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Vol. XXI JULY, 1916. No 7

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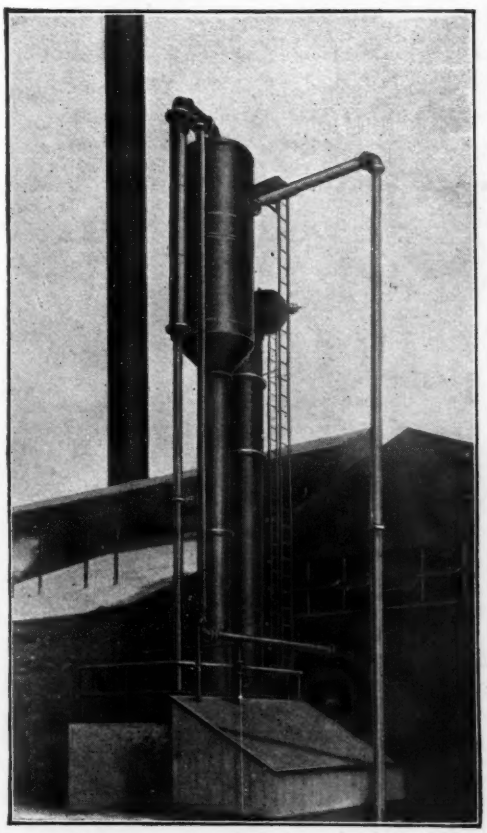

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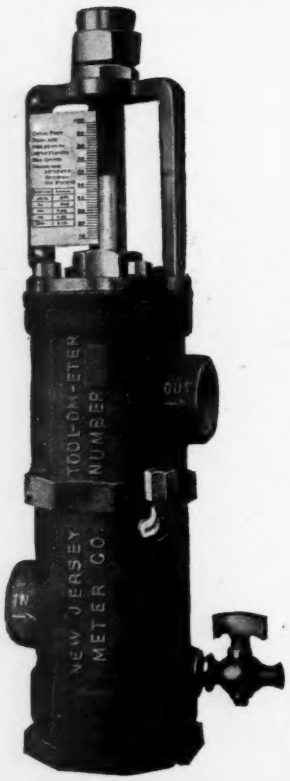

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EVERYTHING PNEUMATIC.

Vol. XXI JULY, 1916 No. 7

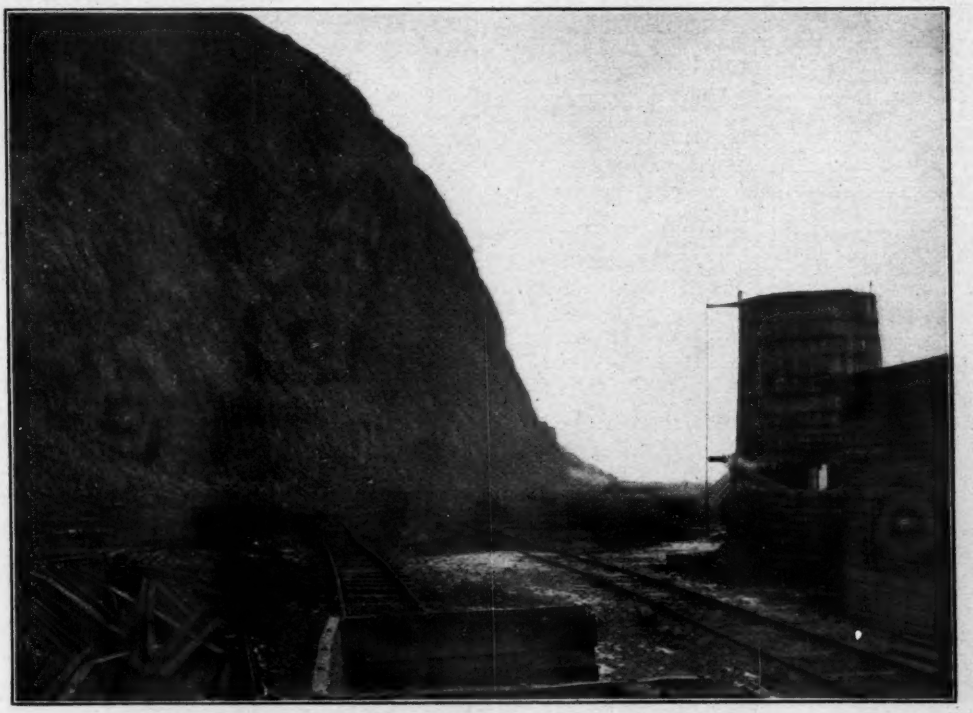

FIG. I. ROCKLAND LAKE TRAP-ROCK QUARRY.

COMPRESSED AIR AT ROCKLAND LAKE QUARRY

BY H. L. HICKS.

One of the largest trap-rock quarries in the United States is at Congers, N. Y., the Rockland Lake Quarry on the west bank of the Hudson River. Many improvements in plant and method of quarrying have been instituted here recently, and the New York Trap Rock Co., who now operate this property, began their second season with an enlarged crusher plant and a steam shovel loading equipment which has increased their output of crushed rock a third and has reduced the loading force to one-tenth.

Quarrying operations, which have been car-

ried on here for 30 years, have "carved a slice out of the mountain" until the present working face is 540 ft. high at the center portion and about 3,000 ft. in length. The level quarry floor is 60 ft. above the river and about 400 ft. wide. The working day is limited by the light and is, at this reason from 6.30 a. m. to 5 p. m. The working force totals about 150 men, 30 of whom are engaged in loading rock at the quarry face. The daily output is about 4,000 cu. yd., an increase of 1,000 cu. yd. over last year's production. The crushed rock is loaded into the company's scows and delivered at any tidewater point.

The rock formation is a very hard, blue traprock, seamy and broken. A series of outwardly sloping cleavage planes, or, as the quarrymen call them, "faults," greatly facilitate the breaking off of large masses of rock with a minimum amount of drilling and blasting. In quarrying, the working face is kept as nearly vertical as possible (Fig. 2), so that the rock will fall at the foot of the cliff, without scattering.

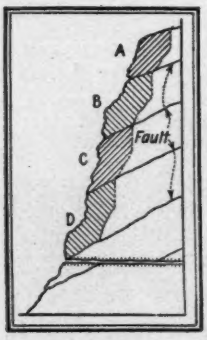

FIG. 2.

While it would seem that the drilling of blast holes on this precipitous quarry face would be an ideal job for a light weight Jackhamer drill, it has been found that to take full advantage of the natural cleavages, deep holes and heavier blasting charges are needed. This brings into use reciprocating piston drills, of which there are five at work.

There is very little earth overburden at the top of the cliff, and in many places the rock is exposed. To remove the upper layer of rock a row of 10 vertical holes about 30 feet apart are drilled 25 feet back from the face. These holes are 18 to 20 feet deep and are loaded with black powder and shot simultaneously. This blast causes a break to extend downward to the first cleavage plane. The force of the explosion tends to throw out the large mass of rock "A" (Fig. 2), while the slope of the natural cleavage line permits it to slide off easily and fall to the bottom of the cliff. The second step in working downward is the drilling of holes on the ledge thus formed. The face of the quarry becomes very irregular and, therefore, it is impracticable to drill these holes in rows. Two or three holes are put in wherever the most rock can be gotten out with the least powder. These odd groups of holes are of about the same depth as the first row and in blasting break to a second "fault." This method is repeated, bringing down successively "B," "C," etc., until the bottom is reached.

When drilling on the ledges it is usually necessary to drive a couple of pegs and fix a plank to hold the drilling machine, steels, etc. The holes for these pegs are often drilled with Jackhamers, as a man can easily handle one of these drills on a very scanty footing. In starting such holes the drill runner descends from the top, taking particular pains to dislodge any fragments of rock which might become loosened while he is at work below.

The deep blast holes are started with 3¼-in. bits and bottom at 1¾ inches—10 changes of steel. Cross bits are used for all this work. The drilling machines and steels are hoisted from the quarry floor up one of several inclined ropeways and lowered or swung into position. This hoisting is done by horses—or by one of the "dinkies" when it is handy.

The drilled blast holes are sprung or "squibbed" with about 25 pounds of dynamite, both to enlarge the cavity for the powder charge and to start lateral cracks into which the powder can be worked, so as to spread the blasting force. "Squibbing" is often repeated when the first charge does not develop a decided cleavage crack. Under favorable conditions and with careful spreading of the powder the rock will break from 15 to 20 feet either side of the drill holes. The black powder blasting charge varies with the character of the rock, 300 pounds being considered a heavy charge for a difficult break.

The rock shatters well in falling, but blockholing of the larger "chunks" is necessary This work keeps seven Jackhamers (Fig. 3), busy, putting in holes averaging 2 feet deep, although at times steels up to 7 feet are needed.

For this work the drill bits used are the "Carr" type, this having been tested and proved to be, in this hard rock, about 50 per cent faster than the 6 point rose bit formerly used. The Jackhamers average from 100 to 200 holes per day. The holes are loaded with 60 per cent. Du Pont dynamite and fired with fuses. The

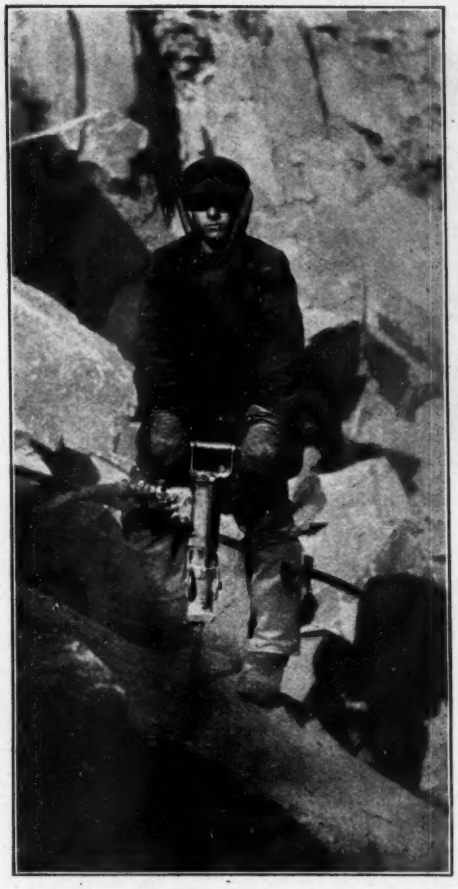

FIG. 3.

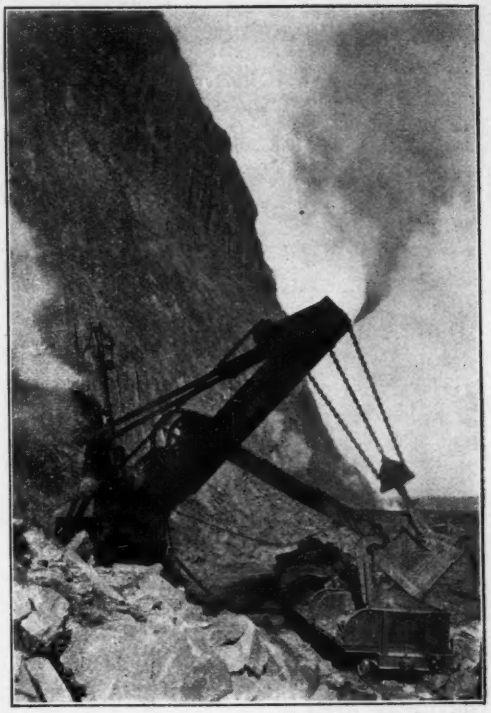

FIG. 4.

FIG. 5.

cost of dynamite for block-holing is now less than $.001 per yard of total output.

Shooting of both blast holes and block-holes is done at noon and night—preferably night—although a few block-holes are often shot at odd times to prevent delay in loading.

The loading equipment consists of two Bucyrus 110C (4 yard) steam shovels loading into open side steel cars. These shovels are said to be the most powerful machines at work in this part of the country.

There are 30 cars, handled in strings of 5 by three "dinky" locomotives.

Loaded cars are delivered by the locomotives to an inclined cableway where they are hauled up into the crusher house (Fig. 3), and dumped directly into the crusher. From here they coast down an incline and up a slight grade toward the upper end of the quarry, where they are switched over and run by

gravity, back parallel with the quarry face. It frequently happens that a car or two cars will not carry past the switch, and to keep the cars in motion a Little Tugger (Ingersoll-Rand), has been bolted to a timber at the extreme end of the track (Fig. 3). This hoist is of the small air operated type originally developed for winze hoisting in mines. When needed this machine hauls two 6½-ton cars up this 6 per cent. grade without any trouble. Fig. 4 shows the remarkably compact construction of this machine. Its weight is only 185 pounds.

The crushing equipment consists of a large 72-in. by 84-in. Taylor Jaw Crusher, 2 8-in. and 8 6-in. Gates Gyratory Crushers and a 72-in. Traylor Roll. These deliver the crushed rock directly to the bins, from which the scows are loaded.

The drill sharpening and blacksmith work is divided between two men. One sharpens the piston drill steels and does the general work and the other operates a No. 5 Leyner Drill Sharpener. This machine is used for forging bits and shanks and resharpening the Jackhamer steels.

The power equipment at the Rockland Lake Quarry is divided between two power houses, the one being a part of the crusher plant and the other a new building at the lower end of the quarry. In the first are installed 4 16-ft. by 72-in. tubular boilers, a 28 by 48 Wright engine, a low pressure Allis-Chalmers turbo-generator, a turbo lighting set, a Wheeler surface condenser and the necessary auxiliaries. Here is also a small air compressor which is held for emergency use. The low pressure turbo-generator is operating on exhaust steam at 1 pound pressure, which the master mechanic says "is as good as finding the power."

The lower power house contains the main air compressing unit an Imperial Corliss steam driven machine of 2,400 cu. ft. capacity, a Westinghouse high pressure turbo-generator, surface condenser and auxiliaries.

The compressor has for an air receiver a horizontal steam boiler placed directly outside the building. From this an 8 in. air line leads to the quarry floor, where two 6 in. branches extend in either direction along the quarry. These air lines are buried to prevent damage from flying rock, and are provided with branch connections at intervals. Air is carried along the top of the quarry by a 2 in. air line, maintaining a pressure of 80 lb. at the drills. In cold weather the air is heated by a crude device, open log fires being maintained under the branch air piping near the point of use.

FIG. 6.

Water for the boiler plants, the shovels and locomotives is pumped by an air lift from a 160 ft. well, this supply being maintained with practically no attention and at low cost. For condensing purposes the slightly salt river water is used.

The pumping of the water is only one of the extra uses to which the air is put. The blacksmith uses it to blow his fire, the Little Tugger hauls cars by air power and the workmen in building a scow (on contract), used air for operating wood borers and a hoisting engine This latter was normally a steam machine with the intermittent operation, totalling at the most an hour of continuous use per day, was found to operate more economically with air than with steam.

BLASTING FOR CLAMS

One of the strangest creatures known to science is the pholas, or boring clam. When still very minute the animal bores into the sandstone ledges at extreme low water, by means of its sharp shell, which is replaced by secretions as it is worn away. It penetrates the rock to a depth of six or eight inches and hollows out its burrows as it increases in size. Shaped roughly like a top, it could not leave its rock dwelling even if it wished to do so. For food it depends on the animalcules that float on the sea water, which it seizes by its

long siphon, or tongue. The pholas is in demand at the seaside resorts along the Pacific coast, for its meat is very tender and makes excellent soup. The clams are dislodged in great numbers from the ledges by the use of dynamite, although it is possible to obtain them with a pick or crowbar.

ENLARGING A WORKING TUNNEL IN ALASKA JUNEAU MINE

BY JOHN RICHARDS.

The cutting of the drainage ditch in the Gold Creek tunnel, the 6,500-ft. working adit into the Alaska Juneau mine, was postponed until the tunnel was completed. The ditch when started was 1½x1½ ft. and ran along the left-hand side of the tunnel. This work was started in July, 1914, with all drilling being done by hand. The difficulty with the ordinary machines working on a column or bar, in this work, was that the tunnel had to be kept open for haulage at all times. This prevented the use of a rigid set-up as the train might come at any time and necessitate the removal of the bar. After two months of hand drilling, however, the Ingersoll-Rand jackhamers were started on the work. The size of the ditch was increased 2x2 ft. at the time the jackhamers were introduced. A summary of the drilled were not obtained on account of the work month by month shows that the average cost of labor per foot when drilling by hand was $1.36, and when using jackhamers it was $0.42. The data on running times and footage intermittent character of the work. Drilling and mucking were done by the same crew, and it was necessary to so arrange the work that the train service would not be interrupted.

A NOVEL PORTABLE JACKHAMER MOUNTING.

In conjunction with digging the ditch, the tunnel, originally of 7x9-ft. cross-section, was straightened and widened to a minimum of 8 ft. In many places the roof was low and this too was taken down. The drilling for this work was done by the jackhamers, the depth of holes drilled varying from 1 to 7 ft. In taking down the roof, a portable mounting, designed in the Alaska Juneau shops, was used to hold the machine in place. This mounting, shown in the accompanying illustration, consists of a short length of 1-in. pipe terminating at its upper end in a small fork which fits around the cylinder of the drill, and its lower end, sliding inside a 1¼-in. pipe with a collar and set screw at its upper end which make possible the adjustment of the fork at any height. At the lower end of the larger pipe, which is about 4½ ft. long, is a larger fork, spreading about 16 in. at the lower points. This fork rests on the ground and gives the whole mounting stability.

NOVEL MOUNTING FOR JACKHAMER.

When using this mounting in drilling, the lower fork is placed slightly forward, giving the mounting a backward slant when starting the hole. As the hole deepens, the mounting becomes vertical and then is inclined to the front. From time to time the upper fork is raised and adjusted by the set screw in order to keep the machine in line.

The chief advantage of the jackhamer in this work was its portability and its ability to drill while so close to the wall or roof, requiring a minimum inclination for the hole and hence a minimum amount of rock broken for the gain made in height or width, and allowing also, longer holes to be drilled.

AIR LENSES FOR DIVERS' SPECTACLES

The indistinct appearance which objects have to human eyes when the eyes are submerged and in contact with water is well known to swimmers and divers. Spectacles have been produced by a European firm which overcome this difficulty, making other eye protection unnecessary. Objects appear indistinct to eyes submerged in water because the

human eye is designed to focus light rays entering it from the air; rays entering the eye directly from water are not properly refracted, and lack of definition is the result. The new spectacles have large hollow lenses, the outer walls of which are plane and the inner walls concave of practically the same curvature as the cornea, an air-tight chamber being in between. With these spectacles a diver has an air chamber always before his eyes and so sees normally. The glasses are fitted with pneumatic rubber rings which are adjusted tightly around each eye, making a chamber between the eye and the lens which is filled with water. Fresh water may be used if the diver is to descend into water so salty that it would be injurious to the eyes. This film of water is very thin, and, having parallel surfaces, does not appreciably refract the light rays, which therefore reach the eyes as if coming from air.—*Popular Mechanics.*

FIG. I. DISCHARGE FROM PIRAHY TUNNEL.

A REMARKABLE TUNNEL RAPIDLY DRIVEN IN BRAZIL

The following account by Mr. J. C. Balcomb, of the Pearson Engineering Corporation, 115 Broadway, N. Y. City, we condense from a recent issue of *Engineering News.* It will appear that the methods and resources of the modern engineer are now equally available all over the earth, so that what is worth noting concerning the Pirahy tunnel here spoken of and the construction of it is in the work itself much more than in the location.

The City of Rio de Janeiro, with a population of over 1,000,000, is supplied with all electric current for light, power and local transportation by the Rio de Janeiro Tramway, Light and Power Co., Ltd., a Canadian Corporation. A hydro-electric plant at Lages, about 50 miles west of the city, is the principal source of power. A succession of dry seasons and an increased demand for electricity compelled the immediate installation of an auxiliary steam plant the cost of operating which amounted to several thousand dollars a day. This enormous expense rendered an additional water supply imperative and the 5¼ mile Pirahy tunnel was designed to divert the Pirahy River into the Lages reservoir.

It will be easily understood that speed was imperative, and so this tunnel 27,657 ft. from portal to portal was completed in 489 days, or say a year and four months, the best single-face monthly record being 512 ft.

The tunnel was bored under three hills, as shown on the accompanying profile, the two end elevations being divides and the center one a round knob. The work was attacked at ten faces by means of four shafts and two portals. One shaft was located very close to the outlet end; therefore, the progress was actually made from eight working faces.

Construction began on approach cuts Nov. 1, 1911, and water was turned into the tunnel on Sept. 28, 1913, an interval of not quite 23 months. The advance heading, 13 ft. wide by 8 ft. high, was probably one of the largest ever driven. It was justified by the expecta-

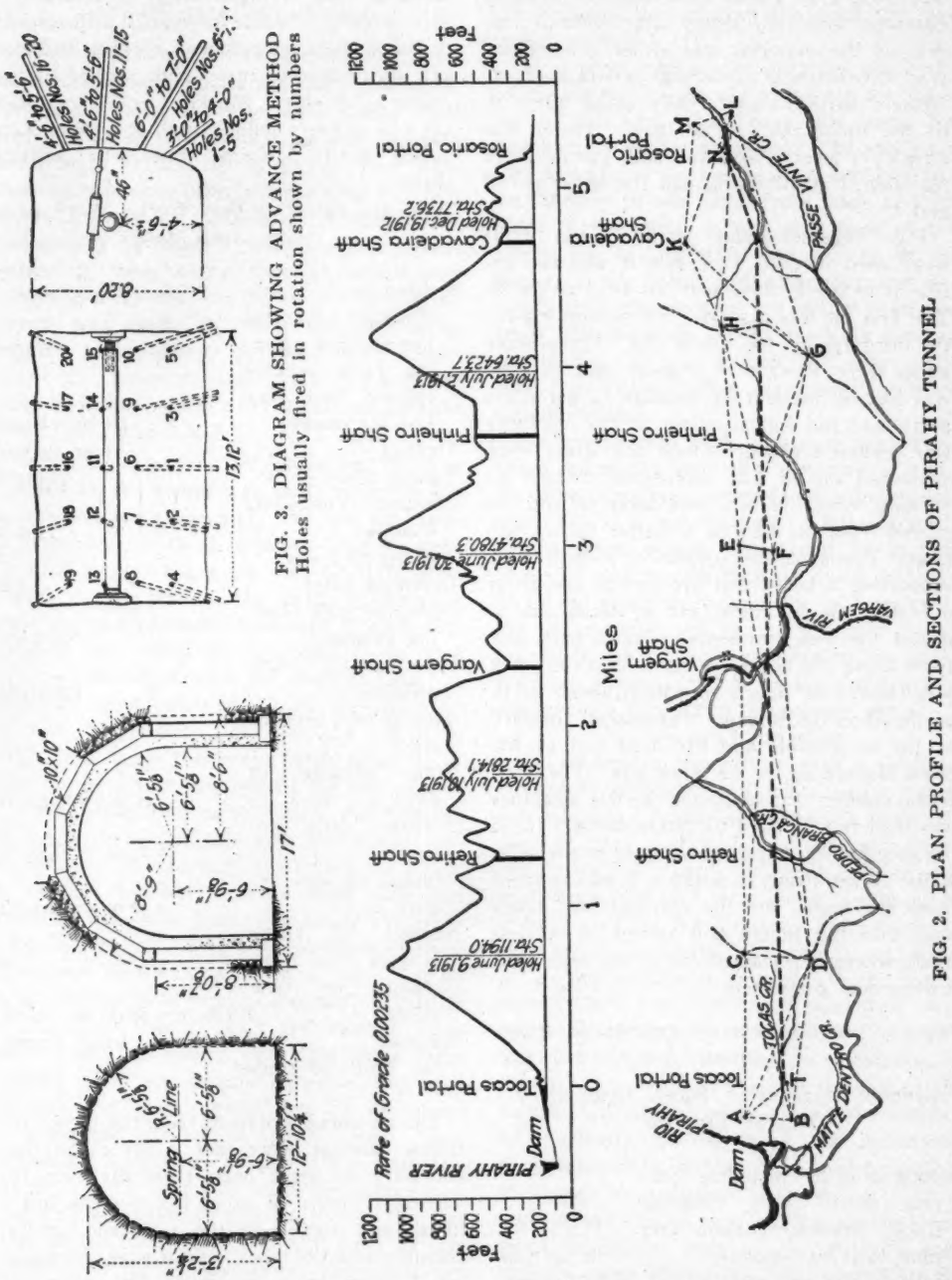

FIG. 3. DIAGRAM SHOWING ADVANCE METHOD
Holes usually fired in rotation shown by numbers

FIG. 2. PLAN, PROFILE AND SECTIONS OF PIRAHY TUNNEL

tion that water would be demanded as soon as the headings met, so that as great an area as possible was desirable, and it was so planned that stoping might be delayed until the demand for water was less urgent. For speed the Swiss system of tunneling in hard rock was adopted—namely, a bottom heading and short rounds thrown well back from the face with plenty of powder in order to facilitate mucking. The times of the several tunneling operations are shown by Table 1.

The rock in about 90 per cent. of the tunnel

was solid gray gneiss of constantly changing character and very seamy and fractious; the rest of the material was either decomposed trap, necessitating timbering, or strata of extremely hard diabase. Only about 1,000 ft. of the tunnel had to be lined. Water was struck in every advance, and pumps were maintained at all shafts and the upper portal end.

Five Ingersoll-Rand 3¼-in. piston drills were used in each face, and it was the endeavor to supply them with air at 95 to 105 lb. The first bit was a 2⅜-in., the second 2⅛-in., the third 1⅞-in., the fourth 1⅝. The powder sticks were 1¼x7 in. A great deal of time was lost on account of inability to get spare parts, and the full economy of the machines was seldom realized. These five drills were supported on an 8-in. horizontal column 12 ft. long, which in turn was taken to and removed from the face by a Carter tunnel carriage. This apparatus consists of a small truck supporting a beam that projects to the front over the pile of muck, and a mechanism to propel the 8-in. horizontal column back and forth along the beam. After a blast the track was cleared of débris to within about 16 ft. of the face, the carriage was pushed forward as far as possible and the head end of the beam blocked up on the muck pile. The horizontal column that supported the five machines was then run forward to within about 4 ft. of the face and there jacked securely to the sidewalls. When firmly in position, it was released from the beam, and the carriage was taken back into the tunnel and stored on a spur track, where it remained out of the way until drilling was completed.

TABLE I. TIME OF PIRAHY TUNNELING OPERATIONS.

General Averages of Faces, Based on 7 Months' Progress.

Setting up drills (including "barring down" roof, cleaning track, blocking column and time lost for smoke)	1 hr. 43 min.
Drilling	4 hr. 40 min.
Taking down drills	20 min.
Blasting (including loading)	58 min.
Average time between shots	7 hr. 41 min.

The number of men actually employed at the working face averaged about as follows: 1 face foreman, 1 muck foreman, 6 drill runners, 6 drill helpers, 22 muckers, 1 extra drill runner and helper to insure full service of machines every shift. Muckers include car pushers and laborers pulling back rock from face. Labor mostly Spanish; three 8-hr. working shifts.

Averages Based on Best Week's Work (Pinheiro, April 16-22)

Setting up drills (including "barring down" roof, cleaning track, blocking column and time lost for smoke)	1 hr. 8 min.
Drilling	3 hr. 46 min.
Taking down drills	14 min.
Blasting (including loading)	33 min.
Number of holes	20
Depth of holes	1.5 m.
Dynamite, 92% blasting gelatin	99 sticks
Dynamite, 62% gelignite	138 sticks
Average time between shots	5 hr. 41 min.
Total advance (7 days 2½ hr.)	41 m. = 134½ ft.
Average daily advance	5.77 m. = 18.93 ft.
Average advance per shot	1.37 m. = 4.49 ft.
Number of blasts in week	30
Dynamite per cubic meter	8.4 lb. = 6.48 lb. per cu. yd.
Material	Uniform gray gneiss, flat roof—no timber.

The advantages derived from the use of the tunnel carriage were that it saved the time necessary to muck back from the face for vertical columns; it saved the men the heavy lifting and tugging of the drills and vertical columns over the muck; and it gave the muckers a clear space to muck out under the column, as the drill runners could stand upon it to crank their machines. The method of drilling, the depth and position of drill holes and the rotation of shooting are shown in Fig. 3.

UNUSUAL BLASTING METHODS.

After the completion of drilling, the holes were cleaned with compressed air by a nozzle on the air hose and afterward nearly filled with gelignite, or blasting gelatin, ranging in strength from 62% to 92%. Very little tamping was done other than stuffing in a few pieces of dampened cardboard that came wrapped around the powder. Only the very highest grade of fuse, every foot of which was guaranteed by the manufacturers to be X-rayed, was used; this was cut into equal lengths and properly prepared with detonators, etc., above ground. (No. 8 detonators were used exclusively after numerous failures with No. 4 and No. 6.)

When the holes were all loaded and the fuse tamped in, the round was made ready to fire in the following manner: The five top fuses in holes Nos. 16 to 20 inclusive (Fig. 3) were left full length; beginning with No. 15 a short length was cut off, and the length of the piece thus cut was gradually increased in each succeeding hole until the first hole to be shot (No. 1) remained with the shortest fuse. A foreman would then peel back the paper on a stick of gelignite, ignite it and use it to "spit" the fuses, beginning with hole No. 1 and finishing with any one of the top holes.

The deliberation with which the Spanish foremen performed this task was almost uncanny; but it was very successful, as it left a distinct interval between each shot and the workmen soon learned to locate the missed hole accurately by a too long lapse of time. A second shot to clear away a bump left by a missed fire was rarely necessary; it usually saved much time to wait and remove these later with Jackhamers and light shots from behind. The men became expert at this style of shooting, and a great deal of the speed attained was attributable to the system. Such a method is contrary to almost any state law in the United States as being too dangerous, but its justification in this case lies in the fact that in the thousands of rounds fired by this method on the Pirahy tunnel there was not a single accident from that cause. After the round had been fired and a reasonable time had been allowed for any missed shots (but without waiting for smoke to clear), the machine runners and helpers went in to bar down the roof and clear the face, while the muckers followed and cleared the track for the tunnel carriage.

As in most tunnels, the progress was limited pirncipally by the ability to get the muck out of the way. To hasten this work, the double-shift system was used. The muck car was brought in by car pushers, and the box was thrown to one side of the track and the truck to the other, a little way back of the face. The resting shift kept an eye on the loaders at the front, and when their car was nearly full, the former got ready to throw truck and car body on the track as soon as the loaded car was pushed by. Very little time thus elapsed when cars were not being actually loaded.

During a record week, cars were loaded and taken out at the rate of a car every 4 min.; the general average under fair conditions was about 6½ to 7 min. to each. Under ordinary circumstances it was found that by keeping plenty of men to rake back the muck from the front and under the column the muckers could get the material out of the way and do all necessary track laying as soon as the drilling was finished and be ready to help the machinemen take down the column, etc.

BONUS SYSTEM OF WAGES.

To encourage the men to take a personal interest in the progress, a unique bonus system was adopted. A minimum month's work was made 75 lin.m., and the bonus began above that figure; for every meter in excess of 75 m. and up to 90 m. the men were given 75 milreis, or about $24.20, per lineal meter. For everything over 90 m. a month, 150 milreis, or about $48.40, per meter was granted. In the record month there was distributed something over $3,550 among 135 men at one face. This bonus was distributed to the men in proportion to the wages received by them at the end of the month. All men known as "smoke eaters," who actually did the hard and sometimes dangerous work at the face, participated in this bonus in proportion to the full amount of their wages; other men helping the progress more indirectly, such as car pushers, cage tenders, steel sharpeners, etc., shared in the bonus in a proportion of from one-quarter to one-half of their wages, the idea being not only to make it an object for the best men to strive to get to the most essential part of the work, but to keep all men interested in the progress. Probably one of the greatest ad-

vantages of this bonus was that it automatically kept the gangs at a minimum number—the more men the less bonus to each and *vice versa*. Also, the men themselves made it convenient for a loafer to quit.

This bonus system worked splendidly throughout the job, and more than any other one thing it was responsible for the great progress made. The disadvantage of this plan, as of any other bonus system, was that it tended to make the men careless, safety and all other considerations being neglected to gain a few meters. The foremen in all instances had to see personally that the men barred down the roof properly and took no unnecessary chances.

It may be interesting to mention here that 200 tunnel laborers and their foremen from the New York subway work were sent down to the Pirahy tunnel to show the Spaniards "how to do it." Most of the Americans turned round and went back north on the same boat that they arrived on. The few who remained were disinclined to work with the horizontal column and preferred the vertical-column method, where the face must be cleared first, losing much time thereby; they refused to use any but electric exploders in blasting and would not go into the smoke like the Spaniards. Furthermore, the American machine runners would not help muck back and assist the progress, as did the Spanish machine runners. This experiment decided for us, at any rate, that American laborers cannot or will not successfully put up with labor conditions as they are met with in Brazil.

After the headings had all met and water had been allowed to run through the tunnel for a few days, it was endeavored to stope during 10 hr. in the daytime and permit the water to run through at night. It was speedily discovered, however, that this was impracticable, as it took several hours for the tunnel to drain, and the proportion of lost time was out of reason. Therefore, the whole force was put to stoping 24 hr. a day, using telescopic drills for stoping, jackhamers for trimming and 52% gelignite for blasting; the record made is shown in Table 1.

When any timbering was necessary, it was found desirable and economical to import timber for that purpose from the United States. The native lumber was principally hardwood, extremely difficult to tool and too heavy to handle economically, particularly in segment work. The Parana pine from southern Brazil was too brash and totally unfit to withstand any great stress. Therefore, practically all timbering except lagging was done with North American pine.

ALLIED WORKS OF PIRAHY TUNNEL.

Across the Pirahy River near the inlet of the tunnel was built a concrete dam of the overflow gravity type. This dam was for diversion only, and the construction involved no unusual difficulties except the ever-present problem of transportation of materials in such a country. It impounded practically no storage water. The flow into the tunnel was controlled by four electrically operated rectangular valve gates each 5x16 ft. These are closed only at rare intervals, when inspection of the tunnel is considered necessary.

About midway of the tunnel and traversing the surface is a small stream called the Vargem River. As there was a shaft at this point, it was decided to utilize this water for storage by diverting it into the tunnel by way of the shaft. It is obvious that, were this water dropped perpendicularly down the shaft, the disturbance created at the bottom would have a retarding effect on the main stream passing; it is equally apparent that if the force of water dropping 200 ft. was properly directed and the force expended in the right direction, it should have an accelerating effect upon the main current of water in the tunnel. So with this in view the water from the Vargem was guided into the tunnel at the foot of the shaft by a reinforced-concrete tube colloquially known as the "snout." This was so constructed (Fig. 4) that the falling water was diverted from a vertical to a horizontal flow down the tunnel by an approximate parabolic curve and at the same time thrown sidewise enough to enter the main stream at a small angle (the shaft proper being situated at the side of the tunnel).

It was almost impossible to make any actual observations or calculations of the effect of the entrance of this water at the foot of the shaft, but it was discovered that it was an extremely hard matter to build a floor there which would withstand the heavy impact of the falling water. The writer had himself lowered with ropes into the tunnel stream one time and observed the action for some minutes, and

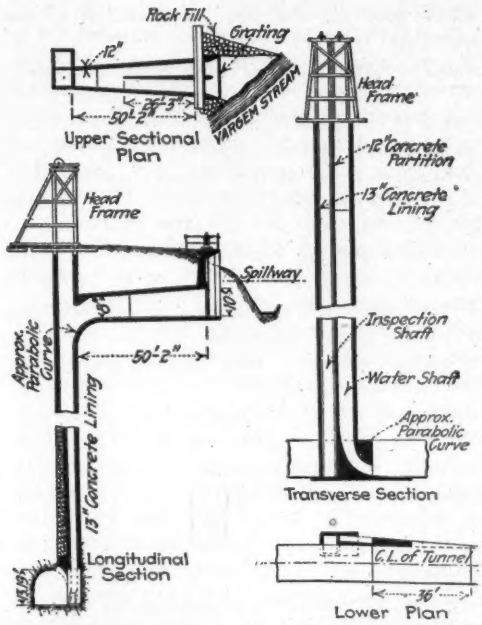

FIG. 4.

from these and subsequent observations it is believed that the falling water actually assists the velocity of the main stream to some extent when the tunnel is running full, as there is no apparent disturbance. When running only half full, the commotion is so great that there must be some slight retardation.

The tunnel was constructed by administration by the Rio de Janeiro Tramway, Light and Power Co., Ltd., of which W. G. McConnel was Chief Engineer until 1913; the late D. H. Campbell was Superintendent, and to him were primarily due the efficient organization and the splendid progress made. The writer was first Chief Engineer of the tunnel, later Assistant Superintendent and eventually Chief Engineer of the Company.

"NOTOWL" FOR DRYING FACE AND HANDS

We have previously mentioned the use of currents of air for drying the hands after washing them. A very complete electrically operated apparatus, called "Notowl," has been devised for this service and we may expect to see it coming into general use. The half tone on this page showing a complete equipment is reproduced by the courtesy of The Edison Monthly. There is a horn for delivering the air which may be set at any convenient height for the hands and can also be lifted to be passed all over the face, and it would also be of service for those who indulge in the foolish practice of washing the hair.

This apparatus not only supplies the necessary flow of air but also heats the air to make it more effective. On pressing with the foot on the lever at the base, air is drawn into the column by a suction fan through the small opening which is seen above the lever. The heating element is in the hood, encasing the air passage for a short distance with incandescent wires. After the machine is set going the heated air is almost immediately forthcoming in liberal volume.

Rated at 11 amperes, the "Notowl" consumes 1,200 watts per hour if it runs continuously, which of course it does not. The cost of operation and maintenance is said to be not more than a quarter of that required for keeping up a decent supply of towels.

"NOTOWL."

ATMOSPHERIC HUMIDITY AND ITS MEASUREMENT

BY KENNETH G. SMITH.*

According to the Law of Partial Pressures, commonly known as Dalton's Law, two gases at the same temperature do not interfere with each other's pressures when mixed, provided there is no chemical action. Each one exerts the same pressure that it would at the given temperature if the other were not present. The total pressure is the sum of the pressures of the two gases. Experiment shows that this law holds good for a mixture of gas and vapor such as water vapor and air. Taking water vapor and air as an example, if Pa is the air pressure and Po the vapor pressure, than Pa + Po = Pt = total pressure of vapor and air. If the vapor is saturated, the temperature of the mixture is definitely fixed at the saturation temperature corresponding to the pressure Pt. If the temperature is higher than the saturation temperature at the given pressure, the vapor is superheated. Water vapor in the atmosphere is superheated except on damp, foggy days, when the water vapor is saturated, or as we say, the air is saturated with moisture.

The weight of a cubic foot of superheated vapor is less than the weight of a cubic foot of saturated vapor. If m_1 is the weight of a cubic foot of saturated vapor and m_2 = weight of a cubic foot of superheated vapor at the same temperature, then the ratio $\frac{m_2}{m_1}$ expressed in per cent. is called the humidity of the air containing the vapor. That is, it is the ratio of the moisture actually contained in the air to that which the air could contain at that temperature if saturated.

If a mixture of air and superheated vapor is cooled at constant pressure (say atmospheric pressure), it will finally reach a point where the vapor becomes saturated instead of superheated and further cooling results in condensation. The temperature at which condensation begins is called the dew point. This is simply the saturation temperature for the given pressure. The gas law PV = constant, which we may assume holds good for low vapor pressures, gives us the means of calculating the ratio $\frac{m_2}{m_1}$ already referred to as the humidity.

Let P_1V_1 represent the condition of saturated vapor at the given temperature and P_2V_2 its actual condition at this temperature—that is, in its superheated state. Then

$$P_2V_2 = P_1V_1 \text{ and } \frac{P_2}{P_1} = \frac{V_1}{V_2}$$

If the vapor is cooled at a constant pressure P_2 down to the saturation temperature—that is, to the dew point—then since P_2 is unchanged the ratio $\frac{P_2}{P_1} = \frac{V_1}{V_2}$ still holds good; now substituting for the volumes per cubic foot, their reciprocals, the weights per cubic foot,

$$\frac{P_2}{P_1} = \frac{m_2}{m_1}.$$

Hence, the humidity in per cent. is equal to the ratio of the pressure corresponding to the dew point to the saturation pressure corresponding to the temperature of the mixture. An example will make this method of measuring humidity clear. Suppose that air has a temperature of 70 deg. and the dew point is found to be 50 deg. What are the humidity and weight of vapor per cubic foot? From a table of vapor pressure we find that at 55 deg. the saturation pressure is 0.436 in. of mercury. At 75 deg. the saturation pressure is 0.8735 in. of mercury. The humidity is then $\frac{0.436}{0.8735}$ = 50 per cent., very nearly. If the air were saturated at 75 deg., it would contain 9.36 grains of moisture per cubic foot. Hence, at 50-per cent. saturation it contains 9.36 × 0.5 = 4.68 grains per cubic foot.

To measure moisture in this way would be difficult under other than laboratory conditions, and for that reason another method, using a wet- and a dry-bulb thermometer, has been adopted. The dry-bulb thermometer is simply an ordinary Fahrenheit thermometer. The wet-bulb instrument is exactly the same except that it has a piece of muslin or other porous material wrapped around the bulb and saturated with water. When both are exposed to the air, the wet-bulb thermometer immediately falls to a lower temperature than the

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other, owing to the fact that the evaporation of the moisture in the cloth requires heat. The drier the air the more the evaporation and the greater the drop in temperature. From the difference in temperature between the wet- and dry-bulb thermometers the humidity may be calculated. In practice it is not calculated, but read directly from a table or curve.

One might naturally ask the reason for the fixed temperature to which the wet-bulb thermometer drops. This temperature is known as the temperature of adiabatic saturation and is fixed for any dry-bulb temperature and percentage of humidity. To understand this statement, imagine three thermometers placed in a body of air to which moisture is to be added without exchange of heat with any source outside of the air and water. The first thermometer is arranged to show the dew point and reads the lowest. The second, or dry-bulb, thermometer shows the dry-bulb temperature or, as we call it, the temperature of the air. The third thermometer shows a temperature between the dry-bulb temperature and the dew point. To make the case concrete, take, for example, air as 70 deg. and 33 per cent. saturated. Then the conditions are as follows: Dry-bulb temperature, 70 deg.; dew point, 39 deg.; wet-bulb temperature, 54 deg.

If now a fine spray of water having a temperature higher than 39 deg. is introduced, the air absorbs moisture, with the result that the dry-bulb temperature drops at once, the dew-point temperature rises and the wet-bulb temperature remains stationary. The reason is that the total heat of the air is constant. The heat required to evaporate the moisture is rendered latent, and the sensible heat as shown by the dry-bulb thermometer becomes less, but the sum of latent and sensible heat is constant. If moisture continues to be added, the dew-point temperature continues to rise, the dry-bulb temperature continues to fall until all three are stationary at the wet-bulb temperature, when the air is saturated. The total heat of the air is the same as it was before the moisture was added, but it contains more latent and less sensible heat. On the total heat the wet-bulb temperature depends, and therefore it is fixed for any temperature and percentage of humidity, because the total heat of the air in the given condition is fixed.

In the example given the percentage of humidity may be calculated if we know the dry- and wet-bulb temperatures. These are as given, dry-bulb 70 deg., wet-bulb 54 deg. The temperature of adiabatic saturation is 54 deg., and at this temperature the air contains 62.14 grains per pound when saturated. The total heat of the mixture equals the heat of the air plus the heat of the moisture, or

$$0.2375 \times 54 + \frac{1{,}084.7 \times 62.14}{7{,}000} = 22.44 \text{ B.t.u.}$$

Since the total heat of the air is constant during the change, the total heat at 70 deg. equals the total heat at 54 deg., or

$$0.2375 \times 70 + (1{,}084.7) + 0.48 \times 16 \times X = 22.44$$

X = Grains of moisture in air at 70 deg.

0.48 = Specific heat of the vapor.

Solving for X, we have X = *37.2* grains per pound of air.

Since saturated air at 70 deg. contains 110.01 grains per pound, the humidity is $\frac{37.2}{110.01} =$ 33 per cent.

A JUVENILE CARVER.

AN AMBITIOUS LITTLE LADY

The little half tone here reproduced from *Granite, Marble and Bronze* shows the interior of the stone carving shop of Mr. C. F. Redding, Hanover, Pa., with his little daughter absorbed in the manipulation of a pneumatic stone carving tool. It is the little lady's ambition to be a good stone cutter, and she is said to accomplish some quite astonishing results. When it was suggested that a picture should be taken she declined unless she could be permitted to put on the overalls "and be a regular boy," and here is the result.

COMPRESSED AIR FOR SINKING A SHAFT

BY F. D. BUFFUM.*

Recently I took a contract for a 650-ft. concrete-lined air shaft to be sunk 3½ miles from Boswell, Somerset County, Penn., for which compressed air power was obtainable free at the power house in Boswell. Its use, as compared to that of a steam boiler plant at the shaft, would effect a saving of $5 to $6 per day in fireman's wages and about the same amount in coal. It was therefore decided to pipe air for this distance.

It was estimated that the machinery to be operated at the shaft would require a maximum of 1,200 cu. ft. of free air per minute. To provide this amount of air with an initial pressure of 100 lb. and a terminal of 80 lb. would have necessitated a 6-in. line, the cost of which would have been prohibitive.

[The drop in pressure under the above conditions of transmission would have been only 8 lb., instead of 20 lb.—Ed. C. A. M.]

A canvass of second-hand pipe dealers showed that there were in stock for sale or lease 10,000 ft. of 4-in. pipe, 3,000 ft. of 3-in. pipe and enough 2½-in. pipe for the remaining distance, capable, if required, of carrying a working pressure of 250 lb. The line was accordingly made up of such a combination. The 10,000 ft. of 4-in. pipe has a volume of about 800 cu. ft., and in order to provide receiver capacity it was laid at the shaft end of the line. The 3-in. pipe was placed next and the 2½-in. pipe covered the rest of the distance to the power house.

A BOOSTER INSTALLED.

In order that this comparatively small line might carry the required amount of air to provide for all contingencies, a "booster" compressor was installed at the power house. This was a 16x11x11-in. Hall single-stage, steam-driven machine. Its inlet was connected to the receiver of the permanent plant and its discharge into the line. With this arrangement the compressor could be cut out or bypassed when not needed, and the line could then take air directly from the main compressors. Twelve hundred cubic feet of air compressed to 6 atmospheres has a volume of about 200 cu. ft. This amount of air passed through the booster and compressed to 250 lb. gage or 264 lb. absolute has a volume of only about 65 cu. ft. This volume would pass through the pipe line described with little drop in pressure.

For use in rock drills, engines, pumps, etc., not more than 100 lb. pressure was desired, and to secure this a Chaplin-Fulton reducing valve was installed at the shaft. It is regulated by weights, which can be quickly placed on or taken off to give any pressure desired, from that in the pipe line down to a very few pounds. It was found that the quantity of air required was not so great but that by raising somewhat the pressure of the permanent compressors at the power house a terminal pressure of 80 to 100 lb. could be secured at the shaft without the use of the booster. The drop in pressure in the line was a variable and depended on the amount of power being used, or the volume of air passing through the pipe.

TAKING THE WATER OUT OF THE AIR.

The most important feature of the plant was, however, the extraction of the water from the air so as to prevent its freezing in severe winter weather and blocking the line. This sometimes occurs in transmitting compressed air in pipes laid on the surface of the ground, as was the case in this installation. The receiver of the permanent plant was located as close as possible to the compressors, so that the air was practically as hot as when it left the machines themselves. Consequently the receiver did not extract the water, and to accomplish this necessary de-watering, the line was laid from the permanent receiver downgrade for about 300 ft. to the bed of a creek, thence under water for about 120 ft. and then up the bank to a receiver located close to a small power house, where men were constantly on duty who could drain it without extra expense.

The air in passing from the compressor to the creek kept the line hot enough to melt snow falling on the pipe, but the creek cooled it, as did also two lengths of pipe through which it passed upward from the creek to the receiver on the bank. The air left this second receiver as cold as it would be at the shaft, and consequently it dropped all the water in the receiver that it ever would drop. There was therefore no gathering of water and freezing in the line.

The cooling of the air to make it drop its water before leaving the receiver was the whole object of this arrangement, which was

*Condensed from *Coal Age*.

designed by Mr. Hildebrand, of the Hope Engineering and Supply Co. In warm weather the creek water, being colder than the atmosphere, cooled the air. In cold weather it had also some cooling effect, though the water was not as cold as the atmosphere. It, however, kept the moisture, dropped by the compressed air as it cooled in passing from the compressors to the second receiver, from freezing, because the temperature of the creek water was necessarily above the freezing point, except of course on its surface, where ice formed.

Until they were buried with a steam line beside them, so they could be warmed a little if necessary, the two lengths of pipe between the creek and the receiver gave trouble from freezing when the mercury fell below zero and a strong wind was blowing. The drain on the receiver would also freeze until a small jet of steam was allowed to play on it in the coldest weather, after which it gave no trouble.

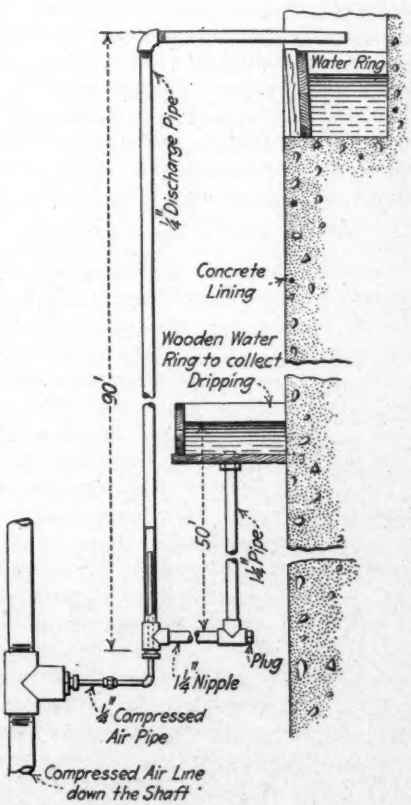
The air delivered to the shaft was perfectly dry, and no case of freezing in the exhaust of any machinery was ever noticed except at times in a 1½-h.p. automatic engine used for driving an electric lighting generator. On account of its variable cutoff and light load this machine expanded the air in its two cylinders more than did the hoisting engines, pumps, drills and engines with throttling governors. The slowing down of this unit was always an indication that the water in the receiver at the power house had not been completely drained off and that some was passing into the line.

After leaving the receiver the air line again passed under the creek, because this was the easiest way to cross it. From here the line proceeded upgrade, except for one small dip, for about 3,000 ft. to a deep hollow. It was expected that if any water got by the receiver it would lodge in this depression if given a chance; so a drip was installed there, experience with the variable cutoff engine having shown that water would occasionally get past the receiver. This was done before cold weather set in, and this precaution was taken in order to avoid any chance of freezing in the line.

The drip consisted of 18 ft. of 8-in. pipe, which formed an enlargement of the line at its lowest point. The air entered this 8-in. section from the 2½-in. pipe and expanded to fill the larger cross-section. This tended to precipitate any water which the air carried. The outlet was through a 2½-in. pipe at the far end. A small drain cock was provided at the lowest point and the whole arrangement was covered to prevent its freezing. This drain section was set so that the far end was slightly higher, allowing the water to drain back.

A few gallons of water could occasionally be drained from this drip, but the bulk of the moisture passed in a steady stream from the receiver drain at the power house, which was always slightly open for that purpose.

The machinery operated by air from the line described consisted of two hoisting engines, a concrete mixer, an electric-light engine and a shop engine (all built for steam operation), two shaft-sinking pumps, a blacksmith forge, an air-lift pump and an air jet for ventilation.



AIR LIFT IN MINE SHAFT.

AN AIR LIFT IN THE SHAFT.

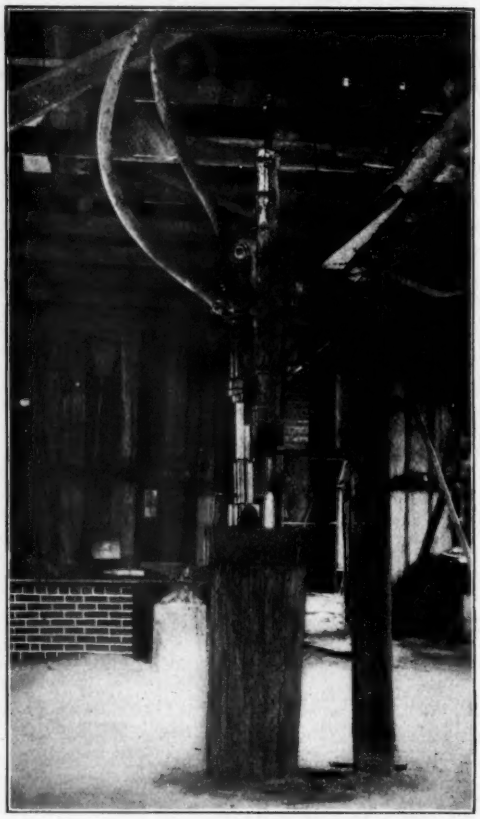
The shaft, see sketch, was provided with a temporary water ring, from which there was considerable leakage, so a second temporary wooden water ring was hung 40 ft. lower. The water in it drains into a 1¼-in. pipe extending about 50 ft. vertically downward to a tee, one branch of which is plugged; the other has a nipple leading to another tee, from which another 1¼-in. pipe leads up so as to discharge water into the upper water ring. Into the bottom vertical branch of the second tee a ¼-in. compressed-air pipe enters and rises about 18 in. into the water-discharge line, which, as just mentioned, leads up from the other branch of the tee. The upper water ring is connected to a pump which discharges the water outside the shaft. This air lift was successful from the start in returning the leakage to the upper ring and pump, which was its object. The plug in the first tee was to facilitate cleaning of the line in case of stoppage.

Below the water rings there are but two pipe lines in the shaft—a 2-in. line for air and a 2½-in. for water. So little water was encountered at the shaft bottom, however, that it was found cheaper to bail it out than to pump it. Consequently the 2½-in. line was turned into a ventilating line.

AN AIR EJECTOR FOR VENTILATING.

As is well known, compressed air does not give much relief when used to ventilate, supposedly because it is too cold and heavy to rise and carry off the gases. A horizontal length of pipe was added to what was formerly the water-discharge line at the top of the shaft so as to get an air inlet far enough away from the shaft mouth to secure pure air, and a 2-in. water ejector was attached. The steam connection of this jet was bushed down for a ¾-in. compressed-air line. When the compressed air is turned on it sucks in the pure outside air through the water inlet, mingles with it and the mixture goes down the shaft through what was the water line, making an effective ventilator, which never gives trouble. The suction of the entering air is about the same as that of an ordinary house-cleaning vacuum system.

The main use of this ventilator is in clearing the shaft of dynamite fumes after shooting. For this purpose, if necessary, steam from a small boiler instead of air can be turned into the air line; but so far this expedient has not been necessary. Steam is of course more effective in clearing away the fumes than air, but in this case its use would necessitate the firing of a boiler for this purpose alone.



ELECTRIC-AIR DRILL AS A BLACKSMITH'S HAMMER

The half tone on this page shows a portion of the interior of the blacksmith shop at Gaunt's Quarry of the Alabama Marble Company, and it mostly tells its own story. The object of interest is the power hammer in the foreground. This is a regular and complete electric air drill of familiar type which has been installed for regular service as a power hammer for the heavier work of the blacksmith. A heavy anvil block is mounted upon the end of a log sunk in the ground the drill chuck carrying a suitable hammer face. At the side of the anvil log a long 6 in. pipe also is firmly bedded with a cast iron elbow

bolted to a flange at the top and to the vertical face of the elbow the drill guide is attached. A stay attached at the back just below the elbow helps to steady the pipe or column. The pulsator is located upon timbers overhead. The drill can be run up or down by the feed screw according to the height of the work on the anvil. It goes without saying that the performance of the hammer is entirely satisfactory.

DRILL STEEL SHARPENING

The following article by Mr. Lucien Eaton, Superintendent of Mines, Cleveland Cliffs Iron Co., Ishpeming, Mich., here reproduced from a recent issue of Mining Press, San Francisco, follows an interesting article in our issue for June by Mr. P. G. Beckett, Mining Engineer, and Mr. I. H. Barkdoll, Mine Superintendent, Old Dominion Mine, Globe, Arizona. Both articles represent successful and established practice, but the particulars are well worth noting, especially as to the differences of gage for the successive lengths of steel. Referring to the previous article, Mr. Eaton says:

I have read with interest Mr. P. G. Beckett's article on "Drill Steel Sharpening at Old Dominion Mine." With a few exceptions the practice at the Old Dominion follows closely the standard Lake Superior Practice of two or three years ago. The greatest variations from present practice are in the large difference in gage for successive lengths of steel, and the welding of "Rocky Mountain" steel on round shanks. It is evident that the ground at the Old Dominion mine is not hard on the gage, otherwise it would be impossible to standardize on two-foot changes; and it is probable that more careful forming of the bits would make it possible to reduce the changes in gage to ⅛ in. and possibly 1-16 in. instead of ¼ in.

The advantage to be gained by such a change is obvious. Assuming that the gage of the longest length of Leyner steel remains at 1¾ in., changes of ⅛ would make the starter 2⅛ diameter instead of 2½, with a cutting area only 70 per cent. that of the starter at present used. If 1-16 changes are used the starter would be 1 15-16 diameter, and the cutting area would be little over 50 per cent. of that of the 2½ in. starter. As a matter of fact the reduction in cutting area, with its consequent increase in drilling speed, would be greater than I have indicated, for the gage of the long drill could be reduced to 1⅝ and still give plenty of room for 1½ in. powder.

I do not wish Mr. Beckett to consider my remarks as adverse criticism of the practice at the Old Dominion mine, as I am not thoroughly enough acquainted with conditions there to pass judgment. I feel confident however, that as much can be done in reducing gage-intervals there as has been done already in the iron and copper districts of Lake Superior. In the Copper Country, Mr. C. D. Lawton, of the Quincy Mining Co., and Messrs. M. M. Morrison and Ocha Potter, of the Calumet & Hecla Mining Co., have perfected their drill-design and drill-sharpening practice to such a degree that they standardize on 1-16 changes in gage for 2-ft. changes in length.

At the Cliffs Shaft mine at Ishpeming, the largest hard-ore mine operating on the Marquette range, I have made it standard practice to use a 1-16 change in gage for foot changes in length, the gage of an 8-ft. drill being 1⅝ in. Six years ago standard practice was to use ⅛ changes in gage for 6-in. changes in length of steel. The steel now used is 1¼ hexagon hollow FJAB No. 10, without lugs. There are 55 Leyner machines in use, of which 35 are using steel with 1-16-gage changes. The other 20 have not yet been changed over from ⅛ intervals..

The rapid strides made in improving drill-bits and drill-sharpening methods have followed the introduction of the Carr bit and are the result of the study of its peculiarities. The Carr bit now used is essentially different from the bit originally designed by Mr. Carr. The original Carr bit had a single cutting-edge, finished at an angle of 120°, with an enlarged hole in the middle. The wings of the bit were formed on a true cone with a taper-angle of 5°, and the flat sides tapered toward the cutting-edge at 4°. In many instances all of these angles have been changed, and the bits are not made on a true cone. It is essential that the two ends of the cutting-edge and the four corners, where the faces of the bit meet the flattened sides, should cut the same circle. This necessarily means that the circle on which the wings are formed shall be larger in diameter than the gage of the bit, the diameter being determined by three factors, namely, the

angle of the cutting-edge, the taper of the wings, and the thickness of the bit at the corners. A change in any one of these factors changes the diameter of the wing-circle. In some kinds of ground Carr bits are not a success, but the principles of their design are equally applicable to cross-bits, and there is no reason to believe that with them results will not be as gratifying.

DRILL SHARPENING PRACTICE.

Following is a brief description of the drill-sharpening methods in use at the Cliffs Shaft mine: Three kinds of steel are used, 1¼ hexagon hollow steel for Leyner drills; 1¼ round solid steel for 3¼ piston-drills, and 1-inch round solid steel for raising-drills. Two styles of bit are used on the Leyner steel: cross-bits and Carr bits. The cross-bits are sharpened in a No. 3 Leyner sharpener, and are gaged in the dies. The gage-changes are ⅛ inch, and the changes in length one foot. The Carr bits are sharpened in a No. 5 Leyner sharpener, but are not sharpened in the dies. The steel is held by the dies, and the bit is 'upset' in the open air, one dolly and one pair of dies serving for all sizes of bit. The steel is flattened between special dies, and is 'swaged' for the wings during the sharpening process in a pair of formers with 15° taper. It is upset to ⅛-in. greater diameter than the gage, and is then brought back to gage by being squeezed in a pair of formers with 6° taper. This method of forging facilitates drawing out the corners. All cross-bits are sharpened in one heat, but Carr bits often require two. On the cross-bits the angle of the cutting-edge is 90° and the taper 15°. On the Carr bits the angle of the cutting-edge is 120° and the taper 6°. All Leyner steel is made without lugs, the shanks being bored out to ⅜ in., countersunk, chamfered, and squared, and then tempered in oil. Breakage is very low.

The solid steel for the raising-drills is sharpened in the No. 3 Leyner sharpener in the same manner as the cross-bits for the Leyner drills, the gage changes being ⅛ in. per foot. The solid steel for the piston-drills is sharpened in a Word sharpener. Cross-bits are used with the angle of the cutting edge 90° and the taper 12°. The changes in gage are the same as for the other cross-bits. The practice of welding 'Rocky-mountain' steel onto the round steel was discontinued about four years ago.

All steel is given a forging-heat from 2 to 2½ in. long in a No. 9 Bradley coke forge, and is allowed to cool thoroughly before being heated for tempering. The tempering heat is made as short as possible, and the bits are quenched by plunging into a tank. The tempering heat is given in a No. 11 Bradley coke forge.

Steel for the piston and Leyner machines is marked on the shank with the number of the contract to which it belongs, and after tempering is sorted and placed in a large rack, in which each contract has a pigeon-hole. The steel for each contract is made into a bundle and held together by an iron ring and wooden wedges. The contract number is then written on one of the wedges with a blue crayon.

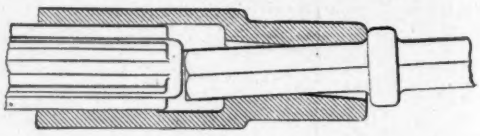


FIG. 1.

FIG. 2.

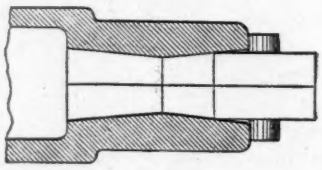


FIG. 3.

CONVENIENT INSPECTION GAGE FOR HAND DRILLS

BY C. C. PHELPS.

There are as many different ways of running a jackhamer as there are of killing the cat of proverbial distinction. One man is partial to the use of his right hand as the guiding force, another uses his left. Another uses both his hands, bearing down with all his weight. It is not unusual to witness a drillman in a restful pose, with one leg slung over the handle as in the half tone herewith.

Motion study does not play much part in the efficient operation of this type of drill. About the same footage can be drilled, irrespective of the way the machine is handled. This is of course largely due to the fact that the rapidity of the hammer blows rather than their force accomplishes the speedy penetration; and the automatic rotation obviates rifling.

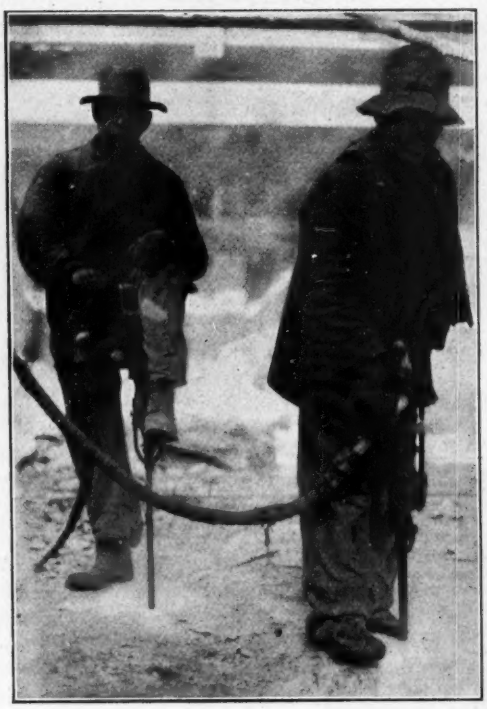


FIG. 4.

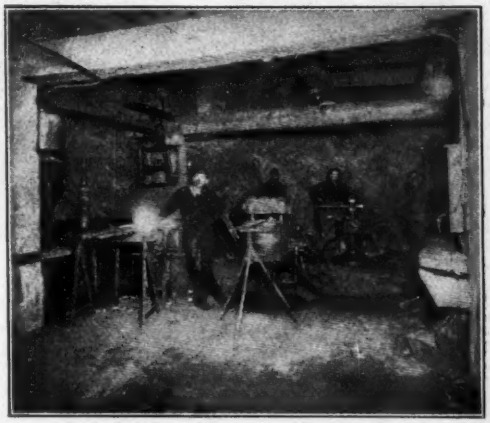
There is, however, one bad feature about careless handling of hand drills which is not generally appreciated—its tendency to increase the repair expense. Careless handling of the machine will tend to keep the steel and drill out of line, and in time this will wear the rotation sleeve in the front head of the drill, as illustrated in Fig. 1. The piston is designed so that the center of its face will strike squarely on the head of the steel shank. It is apparent that excessive wear of the rotation sleeve will permit the end of the shank to come in contact with the edges of the striking face of the piston, eventually chipping off pieces of the latter. These fragments may wedge around the steel or lead to further fracture of the piston. It is therefore highly desirable to inspect the rotation sleeve periodically and replace it before it wears to such an extent as to endanger the proper working of the piston.

For the purpose of determining when a worn sleeve should be replaced, a gage such as that shown in Fig. 2 is used by the test department of the Ingersoll-Rand Co., in connection with experimental machines. This gage, consisting of a piece of 15-16-in. hexagon steel with a pin through it, of about the proportions shown, is used for testing sleeves for 7/8-in. hexagon shanks. When the sleeve has worn sufficiently to permit the gage to enter and the pin to rest on the front head, as shown in Fig. 3, it is an indication that the permissible limit of abrasion has been reached, and that a new rotation sleeve should be substituted.—*Eng. and Min. Journal.*

BLACKSMITH SHOP IN ALASKA MINE

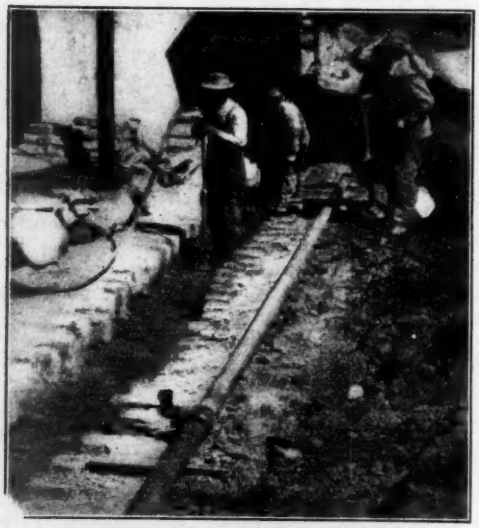
Until the invention of the oil-burning forge in recent years, it was impractical to place the mine blacksmith shop underground because of inevitable vitiation of mine air which is bad enough at best.

An interesting use of an oil-burning forge is shown in the accompanying ilustration in a prominent Alaskan gold mine. This shop is situated on the 2,100-ft. level and about 935 ft. from the shaft. The forge, shown at the left end of the picture, is not divided with smoke or gas flue, and yet the men work without the slightest inconvenience or impairment of health. No special means are used to ventilate this chamber, the conditions being those prevailing in any well-managed mine. This forge supplies the two Leyner sharpeners and accomplishes the duty formerly assigned to two forges operated on the surface. The great advantages accruing from this installation are the avoidance of hoisting and lowering the drill steel, which, in turn, results in the elimination of two nippers on the surface,



the readiness with which every drill-runner is always kept supplied with the proper bits, and—a most important item—an increased ore-hoisting capacity. A similar installation is planned for the 2,300-ft. level, with corresponding economies. The forge in question is the Case low-pressure oil forge made by the Denver Fire Clay Co. The consumption of the fuel varies somewhat, depending on its grade, from 1 to 1½ gal. per hr. It has been found that cheap, ordinary fuel oil, California tops and first or second distillates make a suitable fuel.

The capacity of this forge, when used steadily in large mine shops, is about nine 1¼-in. steels per minute—sufficient to keep the tender busy.—*Eng. and Min. Journal.*



TAMPING TRENCH FILLING

The most important point in the back-filling of trenches excavated in paved streets is the proper tamping of the material. Hand tamping is universally recognized as expensive, and, at the same time, quite often inefficient, and it is well, where practicable, to perform this work by mechanical means. Where compressed air is available, the Crown floor rammers (type 22-SR) manufactured by the Ingersoll-Rand Co. may be used to good advantage. These machines, which consume 28 cu. ft. of free air per minute at a gage pressure of 100 lb. per square inch, are easily operated by one man, who does not need to be a skilled laborer, and they do not require any great amount of care to keep them in order, aside from cleaning and oiling.

Comparative tests of hand tamping and machine tamping have shown that the cost of the latter is about one-third the former, and, at the same time, the backfill is much better tamped.

We have backfilled a 50-ft. section of trench, 24 in. deep and 20 in. wide, containing 6.3 cu. yd., in one hour, with three men shoveling and six men tamping. This backfilling cost $1.80, or 28 ct. per cubic yard, and this ratio of tampers to shovelers insures good tamping. The tamping cost in this instance was 19 ct. per cubic yard.

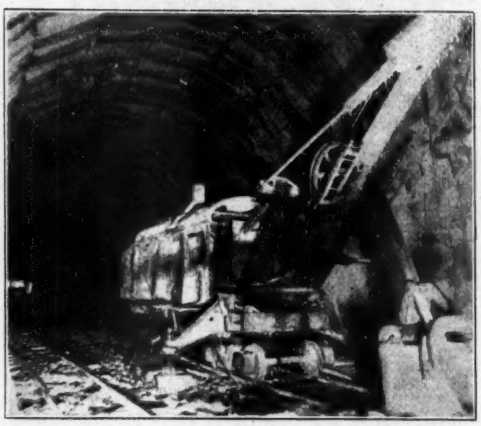
Another 50-ft. section 27-in. deep and 20-in. wide, containing 7.1 cu. yd., was backfilled and machine tamped in one hour, four men shoveling and one man running the rammer. I have never seen earth filling better compacted than it is by these tampers. The cost of this backfilling was 18 ct. per cubic yard, and of the tamping alone, 6.9 ct. per cubic yard.

Other tests have verified these figures, and we have found that, as a rule, the cost of tamping with these pneumatic rammers, on this class of work, is about 7 ct. per cubic yard.

The accompanying illustration shows one of these tampers in operation on Burnside Ave., East of University Ave., Borough of the Bronx, New York City.—*C. M. Hartley in Engineering and Contracting.*

ENGLISH EXPERIENCE WITH PUTTING THE CLOCK AHEAD

The market seems pleased with the Summer Time Act, as it is officially called, or "Daylight Saving," as the public persist in terming it. On Monday, there were no late arrivals at Offices, and the banks had nothing fresh to report. Scarcely anybody seems to feel the difference until evening approaches, which is longer and more pleasant. There is earlier shopping, and trade seems to have benefited rather than the reverse. Trains run according to the "Willett time-table," and, in a word, the only difficulty seems to have been with the cows, which refuse to be milked an hour earlier than usual. As a milkman said when remonstrated with on the late arrival of his commodity: "It ain't no use your putting on the clock if the cows won't give their milk before time."



AIR OPERATED SHOVELS IN TUNNEL WORK

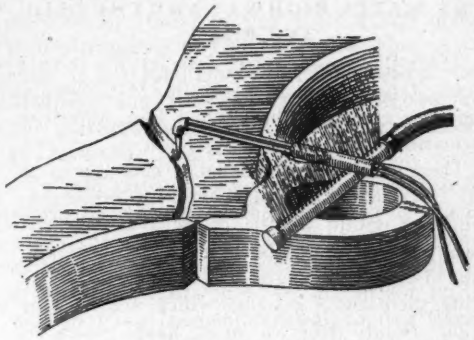
The driving of tunnels for railroad or other service is now such a familiar operation that there is little occasion to mention or describe each undertaking specifically unless there are some novel or unusual conditions involved. The Woodhill and the East Brady tunnels on the Allegheny Division of the Pennsylvania Railroad, begun in 1913 and completed last summer seem to have been in that category, but the photo here reproduced taken while the work was in progress should be of interest to our readers.

The conditions encountered in both tunnels were quite similar. The material for the most part was soapstone and sandstone and crumbled rapidly when exposed to the air so that it was necessary to carry the timber close to the heading. The tunnels were driven by the usual top-heading method by hand. The mucking was done by air operated shovels, one at each end of each tunnel. There were two Bucyrus 40-R's and two Marion Model 41's all with 1½ yard buckets. The half tone shows a 40-R Bucyrus in the mouth of the East Brady tunnel.

The air for the shovels was supplied by two Ingersoll-Rand and one Chicago Pneumatic Compressor. The shovels would work with the pressure as low as 40 lb., but 100 lb. generally maintained was more satisfactory and economical. The material was loaded into two 6-car trains for each shovel. Western 4 yard cars and 18 ton Vulcan locomotives were used. Conditions were not favorable for rapid work, one shovel averaging about 200 yards per day, working 6 hours. The material was dumped along the river bank.

The concrete for lining the tunnel was also conveyed and deposited by compressed air.

The work was contracted by the Allegheny Construction Company of New York, Arthur McMullen, president.



A CURTAIN OF AIR JETS

The failure of a heavy welding job can often be traced to the discomfort of the operator. To stand up to a large preheated casting is often quite a task.

Where air pressure is available, the device shown in the illustration will be found useful. A row of small holes is drilled in a pipe of convenient size to attach to the air hose. The other end of the pipe is closed.

This contrivance is placed across under the torch and held by a clamp or a weight in such a position that a curtain of swiftly moving air passes between the hot casting and the operator. The device affords protection from the heat and does not interfere with the manipulation of the torch or obstruct the view of the operator.—*H. Howard in American Machinist.*

COMPRESSED AIR FOR MIXING AND FOR CONVEYING CONCRETE

In an able article on "Equipment and Operation of Concrete Plants," by A. W. Ransome, in *Contracting,* June, 1916, occurs the following:

Compressed air has been more or less used of late and some extravagant claims have been made as to results. The fact remains, however, that the so-called compressed air mixers do not mix successfully. Compressed air will, however, successfully transport premixed concrete, and in tunnel work will place it economically. Francis Donaldson of the Degnon

Contracting Company used one of these pneumatic machines on the 59th Street section of the new subway. It was a success in placing the mixed concrete, but was rejected as a mixer by the engineers of the Public Service Commission.

THE WATER HIGHWAY AND THE GLIDING BOAT

The following is a brief abstract of a lecture given Jan. 3 by Gonzalo Mejia, of Colombia, before sections of the Second Pan American Scientific Congress.

There is one problem that is common to us all. We have boundless natural resources; we have untold wealth of every description; nature has lavished her rarest gifts upon us. But in order to bring them forth and to derive from them those benefits which are hers by right, South America must have means of communication.

Now, we all know that no network of railways covers the Southern Hemisphere, that many decades must elapse before they can be built; but if we are without an artificial highway, if the rails patiently laid down by the toil of men are lacking, we have a superabundance of natural highways—of mighty rivers which, with their myriad tributaries, stretch in all directions over the face of our native lands. Hitherto they have been of little use, either for intercommunication or for transportation, because our South American rivers abound in shallows and in sand bars and are mostly navigable only for slow rear-wheel boats of insignificant draft.

As air-propelled gliding boats have to overcome only air resistance and the friction of the surface of the waters, the increase in their speed calls for no such enormous increase in motor force as is the case in the regular boats, which have to cleave their way through the waters as they proceed, or even as is the case with the regular hydroplane, the resistance of the water to the submerged screw and shaft of which offset the advantages gained by their gliding qualities. It is a demonstrated fact that at all speeds over 40 miles an hour, the air propeller is more efficient than the propeller in the water for the gliding boats. The record of the regular hydroplane, with submerged screw, is 59 miles an hour, but needed 750 horsepower to attain such a speed. In France, Paul Tissandier made, in 1913, 60 miles an hour in a hydroplane with air propeller and 160 horsepower.

The advance of civilization with all the material prosperity that modern development brings in its train depends upon ease and rapidity of communication. All of that fabulously rich but actually railroadless continent that we South Americans love and cherish as our homeland can be transformed almost over night into one of the portions of the earth best provided with means of communication.

The possibility of building air-propelled boats capable of gliding over the surface of the waters at high speed, safely and surely, is not a theory. It is a fact. There is the *Yolanda* which I have taken up and down the Hudson river for months. I have had on board his excellency the minister of Colombia, Don Julio Betancourt, who can bear me witness, with a number of other gentlemen, that we came from Nyack to New York, a distance of 22 miles, in 35 minutes.

Latin Americans, there is a man who believes that your rivers can be changed into splendid roads, roads that will never show signs of wear no matter how heavy the traffic. This gives you the one thing you lack, means of communication.

NEW SUBAQUEOUS TUNNEL RECORD

What is believed to be a new speed record in driving subaqueous tunnels with the aid of compressed air has been made in the Dorchester rapid transit tunnels under Fort Point Channel, Boston. The best month's run in one tube was 375 ft. of completed tunnel. The average run for the best three months was 325 ft. per month, a large portion of this being in hard-pan. All spoil had to be brought through the shield and out of the air-locks. When the air pressure was first used on the tunnels, early in June, 1915, no provision was made for cooling the air, but aftercoolers were installed a little later. These were 3 ft. diameter and 12 ft. long with about a hundred and twenty 1½ in. brass tubes through which harbor water was circulated.

American ports are better suited by nature to handle the largest liners than any of the old-world ports. At New York, San Francisco, Seattle and Tacoma boats as large as the Imperator or the Aquitania can be docked at any stage of the tide.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

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MULTIPLE EFFECTS OF IMPROVED FACILITIES

We are constantly reminded in all lines of experience of the general principle enunciated by Herbert Spencer, though probably not originating with him, that every active cause is followed by more than one effect. We have an illustration of this in the article upon drill sharpening at Old Dominion mine, Arizona, in the June number of Compressed Air Magazine and, following that, the account in our present issue of drill sharpening practice at Cleveland Cliffs mines, Michigan.

In both cases the pneumatic mechanical drill sharpener is employed, the first result of which is the reduction in the cost of drill maintenance. The ease and quickness with which drills can be resharpened by this means leads to their more frequent renewal, so that when the bits are actually in use they can be working at full efficiency and no time is lost in trying to get all that it is possible to get out of a bit after it is partially worn, or too much reduced in gage. The machine-forged bits are more correct in shape and more accurate to gage, so that the individual difference of gage in the successively following bits is reduced, which means a considerable reduction in the drill hole area for all the steels except the last, consequently a considerable reduction in the amount of chips to be removed and an actual increase in the speed of linear advance, and in the total length of hole per unit of time.

The cheapening and quickening of the drilling does not end with itself but makes it necessary for the other associated operations to be quick and also to keep out of the way of the drilling, so that there is no telling where the influence of the drill sharpener ends. The possible advantages thus made apparent become actual only when they are recognized and appropriated, and, that these advantages may not be missed by any, it is good to talk over, in the technical press or elsewhere, what we each are doing, comparing results and stimulating the worst to emulate the best.

And thus we come upon the everlasting industrial paradox that the doing of any line of work quicker and cheaper and better is the surest way of providing more work to do, one thing leading to another, or to two or three others, without end. Public works of every character are successively made possible by the

increase of the facilities and the cheapening of the methods of execution, so that new enterprises can be planned and profitably carried to completion which only a generation ago could not be thought of, and this mechanical drill sharpener of which we here speak, this glorified blacksmith's helper, stimulates the driving of longer tunnels, the sinking of deeper mines, the winning of additional profits all around, the greater gains coming not from the building of the machines but from the constant use of them.

WATER POWER AND NATIONAL DEFENSE

BY W. R. WHITNEY.

The United States has no adequate source of fixed nitrogen. Nitric acid is an absolute necessity in the manufacture of any form of explosive stuffs. Ammonia or nitrate compounds are in increasing demand as fertilizers. The present dependence upon Chile is a menace in case of war and involves the payment of export duties and profits amounting to nearly $5,000,000 annually in time of peace. Home production is wholly a question of initiative and proper utilization of water power. Failure to establish the industry in the past has been due to economic conditions, such as the relative proximity of Chile and the impossibility of competing with the cheap water powers of Scandinavia as well as lack of a near-by agricultural demand. The growing need for fertilizers, the desirability of establishing a dyestuff industry, and, especially, the feeling of uncertainty in international relations make a reconsideration desirable.

National safety demands the development of a nitrogen fixation industry, whether it be self-supporting or not. But, the industry once established, the products would be of the greatest value in times of peace and would be stimulated thereby. Thorough industrial organization is the best preparedness for either peace or war. Each of the processes available has advantages. The problem is many-sided and far-reaching, and hence it is very desirable that the various government departments concerned, those of the Army, Navy, Agriculture, and Interior, with their skilled staffs and expert knowledge, should co-operate in determining the course to be taken. Immediate action is very important, since at least two years will be consumed in getting any process available into operation after a decision is reached.—*American Institute of Electrical Engineers.*

VALUE OF A SUGGESTION

Dr. Douglas and I were visiting certain works at Swansea to inspect and report upon a patented process or machine, the inventor of which had the right to show it. We were hurried through the old-fashioned smelter, the proprietors evidently not wishing us to see anything except the particular apparatus which was the reason of our visit; but passing a small converter with which some men were tinkering, Dr. Douglas asked them what they were trying to do. With a little reluctance, they told him that they were trying to bessemerize a 37% copper matte, but that their experiments were unsuccessful because their charge continually froze. He asked them what was the pressure of air blast they employed. They said, so many ounces. He replied, "No wonder you froze up! Give the furnace so many pounds." The superintendent exclaimed, "Why, if only a few ounces of air blown in freezes the charge, the same result would be hastened if we increased the pressure!" Nevertheless, they apparently tried it after we left, and when we arrived at our hotel in London, Dr. Douglas received a telegram from the works manager, telling him of their success and thanking him for his hint. Afterwards, he received a formal vote of thanks from the directors.—*Dr. Albert R. Ledoux, Bulletin A. I. M. E.*

AEROPLANE CARRIES SUPPLIES TO A MINE

The aeroplane this spring struck a job of real work, carrying supplies regularly to an isolated mine in British Columbia. At the Dolly Varden mine in the Alice Arm district, a branch of Observatory inlet, a shutdown was threatened on account of the giving out of supplies, due to the unusually prolonged winter weather. A contract was made with the California Aeroplane Co., at a cost of $600 per month and expenses, for an average of two round trips per day between the company's wharf on Alice Arm and the mine, 14 miles distant. Supplies to the amount of 600 lb. were to be carried on each trip.

COST OF A CROSSCUT ADIT

BY W. J. ELMENDORF.*

The main working of the Portland Canal Tunnels, Ltd., consists of an adit 3,671 ft, in length, it crosscutting what is known as the fissure zone of Glacier Creek. The portal of the adit is about 3½ miles north from Stewart, B. C., and 350 ft. above mean high tide at that point.

The heading, 7½x8 ft. in the clear, was driven a distance of 2,916 ft. at an average rate of 8 ft. per day. The best weekly record was 67 ft. and the best monthly 271 ft. Two 8-hr. shifts per day were employed, consisting of four machinemen and three shovelers. After the 1,000-ft. mark was passed, four shovelers were employed. Compressed air at 100-lb. pressure was delivered into the tunnel through a 4-in. pipe. Two 3¼-in. Ingersoll-Rand E44 drills, mounted on a 7-ft. single screw bar, were used. Miners and shovelers started work together. The bar was set up above the rock pile, and from 10 to 12 holes were drilled from this position. By this time the rock was out, the bar was lowered, and three lifters were drilled. The first 1,600 ft. of the tunnel is in greenstone, while the remainder is in argillites, quartz and porphyry

With but two exceptions during the entire work, a round was drilled in every shift. Five-foot rounds were drilled, but seldom "bottomed." Three 20-cu. ft. cars were used, and tramming was done by the shovelers. The track of 20-lb. rails, 18-in. gage and ½% grade, was laid on the left-hand side of the tunnel. One switch, about half way in, was used; the empty incoming car was taken off the track near the face to allow the loaded one to pass. At a point 730 ft. from the portal an 80-ft. adit was run, opening into a cañon. This not only made an excellent dumping place, but shortened the tramming distance by 750 ft. The shovelers laid and leveled the track. The floor from within 3 ft. of the face to 40 ft. back was covered with steel plates before blasting. A drain 12 in. deep was made on the right side of the tunnel, the lifter being drilled low for this purpose.

Ventilation was provided by two Schütte & Körting blowers. The ventilating line consisted of 10-in. diameter 24-gage galvanized pipe. The pipe was made in 10-ft. lengths with riveted joints, painted with tar and wrapped with muslin. The compressor was run two hours after blasting to clear the tunnel.

TIME AND COST OF OPERATIONS

Average Time of Operations

	Hr.	Min.
Picking down and setting up	1	00
Drilling from upper set-up	4	30
Shoveling back and lowering bar	0	30
Drilling from lower set-up	1	15
Tearing down	0	10
Blowing out holes	0	5
Loading	0	15
Total	7	45

Detailed Summary of Costs

Labor:	Cost per Foot
Machine men	$3.953
Shovelers	3.673
Timbering	.258
Drainage	.042
Ventilation	.077
Ties and wedges	.135
Compressed-air line	.072
Compressor men	1.166
Blacksmith and helper	1.216
Superintendent	.876
Total	$11.468
Supplies:	
Powder	$2.562
Fuse	.134
Caps	.032
Candles	.145
Blacksmith coal	.125
Machine drills and parts	.503
Drill steel	.118
Timbers	.052
Repairs on compressor	.027
Oils	.031
Miscellaneous	.073
Total	$3.802
Equipment:	**Total Cost**
Muck sheets	$110.00
Steel rails	1,290.00
Ventilators	225.00
Ventilating pipe	960.00
Compressor air line	1,070.00
Cars	400.00
Total	$4,055.00
Length of tunnel	2,916 ft.
Total cost	$48,584.01
Cost per foot	$16.661

All supplies were bought at Vancouver, B. C., and sent north by steamship. The prices of some of the more important supplies at the tunnel were as follows: Dynamite—40%, $0.134 per lb.; 60%, $0.159 per lb. (powder was used in about the proportion of 30% of the former to 70% of the latter); steel rails (20-lb.), $72.24 per long ton; blacksmith coal, $27 per ton.

The scale of wages was as follows: Machinemen and shovelers, $4 per day; blacksmiths and compressor men, $5. Beyond the point to which these figures apply, the size of

*Can. Min. Inst.

the tunnel was cut down and the costs decreased about $1 per foot.

COMPRESSED AIR SOLVES A CITY'S WATER PROBLEM

After years of perplexity, of partial successes and more than partial failures, the problem of securing a satisfactory and permanent supply of water for the city of Joliet, Illinois, has been happily solved by the adoption of the air lift. Water is present in more than sufficient quantity in the neighborhood of Joliet. The Chicago drainage canal runs through the heart of the city, and it would have been possible to purify this for domestic use, but the citizens quite naturally declined to use it and artesian wells were adopted. There is a water bearing stratum 600 to 900 ft. below the surface, which, however would not yield a sufficient supply, but the Potsdam stratum at a depth of 1,600 ft., and 110 to 150 ft. thick can be relied upon both for quantity and quality. It normally rises to 100 ft. from the surface.

There are now 10 wells running to the Potsdam stratum, located at widely separated points, generally encircling the principal section of the city. These wells are quite uniform in general details. For the first 300 ft. of depth there is a 16 in. casing, and below this is solid rock with no casing provided except where caving might occur.

The equipment which has been adopted as standard for the wells consists of a Harris air pump placed at the bottom end of a 6½-in. discharge pipe. The running submergence desired is 55 per cent., but at some wells it is 50 per cent. The average static head is 100 ft., and the recession 100 ft., making a working head on the air-lift pump of 200 ft. and the depth of the air-lift pump 450 ft. An auxiliary air line is placed at such a depth that no greater air pressure is neded for starting than for running. At most of the isolated plants the water is discharged through an umbrella head or reverse bend into a concrete weir box from which it is pumped by means of triplex pumps into the city mains.

At the main pumping station are 4 wells which discharge into reservoirs. The wells being located 300 to 350 ft. from the reservoirs, it is necessary to pipe the water horizontally from the wells and elevate it about 10 ft. from the top of the wells, so Harris boosters are employed here.

PUMPING INSTALLATION.

The mechanical equipment employed comprises one main plant and six isolated plants, electric power for driving the latter being supplied at a low rate by the Public Service Corporation, while at the main plant the air compressors are similarly driven and the power pumps are driven by steam.

At the main plant are two Ingersoll-Rand, Imperial XB, compressors, each 22 and 13 dia. of air cylinders by 16 in. stroke, compressing in two stages to 100 lb. gage pressure. The drive is by Westinghouse induction motors of 200 h.p. each, with short-belt drive. The air intake is through screened pipes from outside, and the delivery to individual air receivers also outside the walls. From the receivers the air is taken through a manifold to the wells.

There are here two reservoirs which receive the water direct from the wells and hold it in storage for night use, when the isolated plants are shut down, and for emergency use as needed. There are two steam driven pumps for delivering water from the reservoirs into the mains. Jet condensers are used with these pumps.

The Washington Street or main plant takes care of all peaks on the system and is in operation day and night. All pressure pumps discharge directly into the mains, but the pressure carried at different stations varies with the elevation. The minimum pressure at the highest elevations of the city is 25 lb. In case of fire, the pressure can be raised to 150 lb., the pipes being sufficiently strong.

Each isolated plant pumps from one well, the machinery consisting of a motor driven air compressor and a motor driven triplex plunger pump.

At the Ottawa St. plant, water is delivered at the rate of 1,000,000 gal. in 24 hr. Air is compressed by a Laidlaw-Dunn-Gordon 2-stage compressor to 90 lb. pressure and the water is delivered to the mains by a Deane of Holyoke triplex pump. One 200 h.p. motor drives both machines through belt connections.

The Canal St. well has a capacity of 900,000 gal. in 24 hr. and the machinery here consists of a Laidlaw-Dunn-Gordon compressor and Deane of Holyoke pump driven by individual motors. At this plant, the water from the well is slightly contaminated with oil and gas, presumably from a gas plant nearby. Al-

though every possible precaution was taken to prevent water from upper strata from getting into the well, the trouble still existing, and to overcome the trouble the city engineer, C. D. O'Callahan, devised a scheme for aerating the water which has eliminated all objections.

AERATING THE WATER.

Water from the well is discharged over steps and descends into a concrete reservoir 75 ft. long to 20 ft. wide and 7 ft. deep. This is divided into compartments of about 7 ft. each with a center wall passing longitudinally through the reservoir. The partitions forming the several compartments in the reservoir act as baffles, the water passing over one and under the next one and so on up one side and back on the other, the partition in the center forming virtually 2 reservoirs.

A system of pipes is laid leading into each compartment of the reservoir, which were perforated and rested upon the bottom of the reservoir. Air is delivered through these pipes to each compartment at low pressure, allowing the air to bubble up to the surface, causing little agitation at the surface of the water. A considerable amount of oil and grease collected on the sides of the first compartment in the reservoir which receives the water after it passes down the steps. Small amounts were also collected in the next and succeeding compartments, but by the time the water reaches the last compartment no oil appears on the surface and the odor of gas is entirely eliminated.

At the time of the last test, the Desplaines St. well delivered water at the rate of 500,000 gal. in 24 hr. The equipment here is an Ingersoll-Rand compressor and a Goulds triplex pump run by belts from individual motors.

An Ingersoll-Rand compressor and a Goulds triplex pump with individual motor drive are installed in the Spruce Slip plant. When last measured, this well was yielding water at the rate of 540,000 gal. in 24 hr.

At the Van Buren St. well a Laidlaw-Dunn-Gordon air compressor and a Deane triplex pump are driven by individual motors, the flow of water at the last measurement was at the rate of 540,000 gal. in 24 hr.

The most recent plant of the system is at the Ruby St. well. Here an Ingersoll-Rand compressor and a Goulds triplex pump driven by individual motors are the principal machines. The switchboard equipment at this plant is the standard which has been chosen for future installations and consists of 3 panels upon which are mounted 2 circuit breakers and a polyphase watt-hour meter, 2 controllers and 2 rheostats complete the equipment, all of which was made by the Westinghouse company. This well yields at the rate of 1,500,000 gal. in 24 hr., the air compressor being driven by a 150-hp. motor and the running head against which the water is raised is 250 ft.

For the information here presented we are indebted to a more elaborate illustrated article in Practical Engineer, Chicago, June 1.

NOTES

Some English railway companies have been disconcerted lately by receiving claims for damage to flour through its getting wet, where there were no signs of the tarpaulins being defective, if conveyed in open wagons, or of rain beating through the doors if vans were used. The explanation has now been found in the fact that through the millers working at high pressure, the flour is loaded whilst warm, and this has brought about condensation from external cold.

Sir Robert Hadfield, the noted English maker of projectiles, is authority for the statement that the useful life of a modern high-velocity gun is about three seconds. Which is to say that the time taken by the shell in traveling through the gun, from powder chamber to muzzle, multiplied by the total number of rounds that can be fired before the rifling is so worn as to impair the accuracy, gives a total useful life of only three seconds. Rather a short life for, let us say, a 12-inch gun costing $50,000 to $60,000. It is understood that the wearing here spoken of is not so much a mechanical abrasion as it is an actual burning of the metal by the intense heat of the charge.

E. G. Fischer, chief of the instrument section of the coast and geodetic survey, department of commerce, has just completed the design and construction of a signal lamp which will be used during the coming summer in the mountainous regions of Idaho and Oregon on primary triangulation where the distance between stations is frequently as much as 100 miles. This lamp has been tested by the bureau of standards and is shown to be more

than 150 times as powerful as the acetylene signal lamps which have been used for a number of years by the survey. These acetylene lamps have been observed with the telescope over lines more than 120 miles in length. The new lamp is an electric one, with a specially designed filament, and the power is the ordinary dry cell.

By arranging channels in the crowns of the ends of open-hearth furnaces and connecting them with a compressed-air conduit, Regnier Eickworth of Dortmund, Germany, in a U. S. patent recently issued claims to prolong the life of a furnace by passing air through the channels so as to cool the crown and also exercising a cooling effect on the exhaust channels. The system is applied to both ends of the furnace, connected to a common compressed-air line with a reversing valve at the junction.

The 42-centimeter and other big guns, so often referred to in this war, are howitzers, of low velocity (say 1,000 to 1,500 feet per second) and using pressures in the powder chamber of about 14 tons to the square inch. The high-velocity naval and coast-defense guns have velocities of from 2,500 to 3,000 feet per second, and powder pressures of 18 to 20 tons per square inch. J. A. Longridge, the father of the wire-wound gun used so extensively by the English, stated many years ago that guns could be built to stand 30 tons pressure.

Many explosions have occurred in connection with oil firing. Practically these are true gas explosions, as liquid fuel is virtually converted into gas before burning. These accidents, states a writer in the *Vulcan*, have principally arisen in one of two ways. First, the oil is turned on and gasified during some appreciable length of time before lighting, so that the furnace is more or less completely filled in the meantime with an explosive mixture of gas, which is fired when the jet is lighted or when it is brought into a full flaming condition. Secondly, some part of the oil escapes the gasification process by reason of some defect in the burner, while the flame is burning more or less imperfectly, and the mixture is fired when the temperature of the flame is increased.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MAY 2.

1,181,125. STEAM-BLOWER. HENRY L. ERLEWINE, Marion, Ind.

1,181,240. AIR-PUMP-CONTROLLING DEVICE. HARRY W. MUNYAN, Worcester, Mass.

1,181,325. AIR-PUMP. HARRY W. LOCKLEY, New Castle, Pa.

1,181,333. AUTO-AIR PIPE COUPLING. CHARLES H. MONROE, Carbondale, Pa.

1,181,347. AIR AND LIKE FLUID COMPRESSOR AND EXHAUSTER. CHARLES LEONARD DE WILDE READER, Hursley, near Winchester, England.

1,181,373. GRAIN-SAVING DEVICE FOR THRESHING-MACHINES. CHARLES R. DAIGH, Parsons, Kans.

1,181,374. AIR-COOLED HOLLOW SLAG-POCKET. GEORGE L. DANFORTH, Jr., and SAMUEL NAISMITH, Chicago, Ill.

1,181,450. APPARATUS FOR PRESSURE RELEASE. HUDSON H. HOUSE and CHARLES E. BRUNELLE, Peekskill, N. Y.

1,181,459. BLOWER. ANTON KALTENBRUNN, St. Nazianz, Wis.

1,181,492-3. MOLDING-MACHINE. HENRY TSCHERNING, Freeport Ill.

1,181,515-6. APPARATUS FOR GASIFYING LIQUIDS. GEORGE A. EYNON, Cleveland, Ohio.

1,181,536. COMPRESSED-AIR MOTOR. JOHN W. OMAN, St. Louis, Mo.

1,181,584. INTERMITTENT TRANSMITTER FOR CARRIER-DESPATCH SYSTEMS. MERTON L. EMERSON, Braintree, Mass.

1,181,677. ART OF TRANSPORTING MATERIALS IN BULK. THOMAS W. MCNEILL, Chicago, Ill.

1. The art of conveying small, solid articles, such as pickles, sauer-kraut, and the like, from a point of supply to a delivery chamber, which consists in, submerging the solids in a protecting liquid, the surface of which is exposed to atmospheric pressure, establishing an area of rarefaction, and alternately, first, closing the delivery chamber to the atmosphere and establishing communication thereto from the area of rarefaction, establishing communication with the supply beneath the surface of the liquid, and second, shutting off communication between the delivery chamber and the area of rarefaction and opening the delivery chamber to the atmosphere for contents delivery.

1,181,755. AUTOMATIC AIR-COUPLING DEVICE. ALFRED B. FITZGERALD, Blackstone, Va.

1,181,886. AIR-MOISTENING DEVICE. JAMES P. HIGH, Fairview, Okla.

MAY 9

1,182,084. FLUID-COMPRESSION APPARATUS. ALAN K. GILLESPIE, St. Louis, Mo.

1,182,089. AIR-PURIFIER. HENRY J. HERT, Indianapolis, Ind.

1,182,094. ELEVATOR-INDICATOR. ALEXIS LE BLANC, New York, N. Y.

1. The combination of an elevator car and a pressure responsive device for indicating the position of the car and a flexible cord connected with the car, of a fluid containing receptacle communicating with the pressure responsive device, and means connected with and arranged to be actuated by the weight of the flexible cord for varying the pressure on the fluid in the receptacle as the position of the car is changed.

1,182,150. BLOWPIPE. JAMES H. DOWNIE, San Antonio, Tex.

1,182,215. PULSATOR FOR MILKING-MACHINES. FRANK H. SCHLEY and CLEMENT F. KIMBALL, Council Bluffs, Iowa.

1,182,260. DOMESTIC VENTILATOR. JOHN C. FLEMING, Boston, Mass.

1,182,315. GENERATION OF POWER. JOHN G. ROBINSON, Melrose, Mass.

1. In combination, a reservoir, a plurality of tanks arranged above said reservoir, a pipe connection between said tanks and reservoir, an outlet pipe communicating with each tank, means for creating a vacuum in said tanks successively whereby continuous streams of water are caused to flow up and down said pipe connection and said outlet pipe respectively, an energy-translating device in said pipe-connection, an energy translating device in said outlet pipe, and means mechanically connecting said energy-translating devices, said energy-translating devices being simultaneously operated by the ascending and descending streams of water respectively.

1,182,343. COTTON-BOLL THRESHER. ANDREW J. BRYAN, Graham, Tex.

1. In a device of the character described, a pneumatic flue, a baffle plate separating said flue into two compartments, a toothed cylinder rotatably mounted in one of the said compartments, a breast coacting with said cylinder, and a bar carried by the baffle plate, said bar having guard pins cooperating with the toothed cylinder.

1,182,372. AIR-COMPRESSING PUMP. GEORGE I. HIPPLE, Chicago, Ill.

1,182,433. RESILIENT PNEUMATIC WHEEL. DAVID D. STONER, Cincinnati, Ohio.

1,182,460. APPARATUS FOR DISCHARGING DANGEROUS LIQUIDS AND GASES. ERNEST B. CRUGER, New York, N. Y.

1,182,507. AIR-COMPRESSOR. EDWARD A. RIX, San Francisco, Cal.

1,182,550. AIR-CIRCULATING MECHANISM. WILLIAM A. FREEMAN, Shreveport, La.

1,182,595. VACUUM-CLEANER. ALFRED J. STECKER, Detroit, Mich.

1,182,599. APPARATUS FOR MAKING HOLLOW RUBBER ARTICLES. HERBERT RALPH STRAUSS, Cleveland Heights, Ohio.

1. An apparatus for making inflated articles comprising air compressing mechanism and a separable mold adapted to occupy the air chamber of the compressing mechanism and be automatically closed and locked closed within the same.

1,182,624-5. HUMIDIFYING DEVICE. ALBURTO BEMENT, Chicago, Ill.

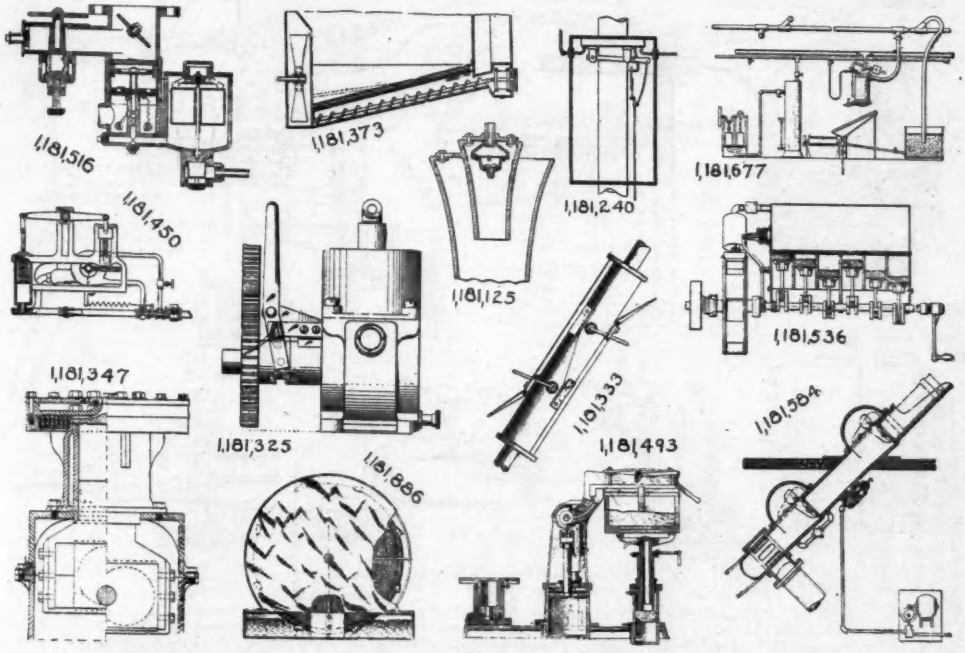
1,182,684. AUTOMATIC AIR AND STEAM COUPLING. DAN DUNBAR HOWE, Norfolk, Va., and GEORGE HOWE, Sparrows Points, Md.

1,182,774. AIR-PRESSURE BRAKE. PAUL KORT, Hanover, Germany.

1,182,811. MACHINE FOR GATHERING AND MOLDING GLASS ARTICLES. LEWIS STEELMAN. Millville, N. J.

1,182,836. AUTOMATIC TRAIN-PIPE COUPLING. LEWIS CLEAVLAND CARY, Los Angeles, Cal.

1,182,878. VALVE FOR GLASS-BLOWING MACHINES. WILLIAM E. STANDLEY, Pittsburgh, Pa.



PNEUMATIC PATENTS MAY 2.

MAY 16

1,182,937. SUCTION-VALVE FOR COMPRESSORS, ENGINES, PUMPS, AND THE LIKE. JAMES JOHN SMITH, Brisbane, Queensland, Australia.

1,183,031. INDICATOR FOR AIR-BRAKES. JOHN E. PRICE, Wilmington, Del.

1,183,063. AIR - CYLINDER - LUBRICATOR SYSTEM. WALLACE E. DUNKERLEY, CHARLEY A. MATTMILLER, and JOSEPH BRUNKER, Helena, Mont.

1,183,071. PNEUMATIC RELEASE DEVICE. JACOB W. KAISER, East Cleveland, Ohio.

1,183,077. COMPRESSOR. JOSEPH KOENIG, Two Rivers, Wis.

1,183,078. MARINE LIFE-SAVING APPARATUS. JOSEF KONRAD, Spokane, Wash.

1. In a marine life saving apparatus, a ship, an air tight habitable housing mounted on said ship, a buoy having an air intake and being free to remain on the surface as the ship sinks, and a hollow air supplying conduit connected

with said buoy and with the interior of said housing, substantially as described.

1,183,103. AIR-BRAKE APPARATUS. SPENCER G. NEAL, Los Angeles, Cal.

1,183,129. PORTABLE PNEUMATIC PUMPING APPARATUS. HOWARD SMALL, Atlantic City, N. J.

1,183,168. GOVERNING DEVICE FOR PNEUMATIC PIANO-PLAYER ACTION. MELVILLE CLARK, Chicago, Ill.

1,183,175. STEAM-PUMP OR AIR-COMPRESSOR. KENNEDY DOUGAN, Minneapolis, Minn.

1,183,198. CARRIER FOR PNEUMATIC-DESPATCH TUBES. BURTON U. HILLS, Chicago, Ill.

1,183,274-5. ROCK-DRILL. OMAR E. CLARK, Denver, Colo.

1,183,862. PNEUMATIC MOTOR. CHARLES FREBORG, Kankakee, Ill.

1,183,912-3. ELECTROPENUMATIC BRAKE. WALTER V. TURNER, Wilkinsburg, Pa.

1,183,952. PNEUMATIC SWEEPER AND RENOVATOR. ALONZO E. CHAPMAN, San Francisco, Cal.

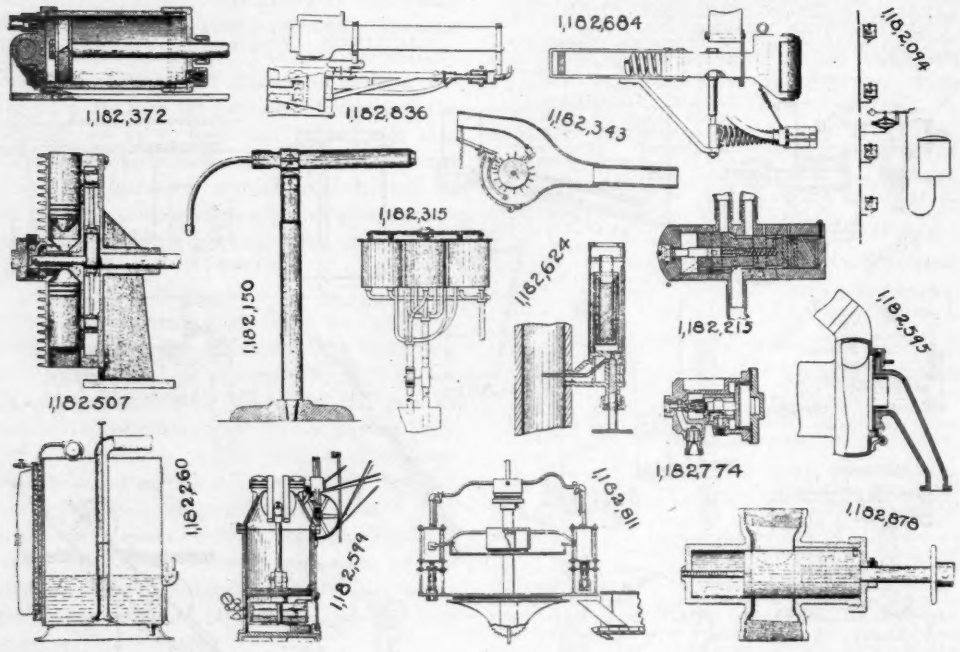
1,183,998. HYDROCARBON-BURNER. JAMES W. MARRIOTT, Manayunk, Pa.

1,184,040. AIR-PUMP. IRA H. SPENCER, West Hartford, Conn.

1,184,150. PNEUMATIC COTTON PICKING AND TRANSFERRING MACHINE. WILLIAM M. TULLEY, Corpus Christi, Tex.

1,184,172. PNEUMATIC MOTOR MECHANISM. PARIS R. FORMAN, Chicago, Ill.

1. In a pnuematic motor mechanism, differ-



PNEUMATIC PATENTS MAY 9.

1,183,412. FLUID-PRESSURE ENGINE. ALESSANDRO VALENTE, London, England.

1,183,417. BLOWER DEVICE FOR CLEANING TUBES. HERMANN ZEITZ, Hamburg, Germany.

1,183,484. AIRSHIP. EDWARD HUNTER PAGE, Covington, Va.

1,183,496. AIR - PUMP. FRIEDRICH ALBERT RUNGE, San Marcos, Tex.

1,183,644. PNEUMATIC-HYDRAULIC GUN. ROLLIE CALVIN HILL, Memphis, Tenn.

1,183,660. ROTARY FAN. MARY MAHAN, Kansas City, Mo.

1,183,719. AUTOMATIC AIR - COUPLING. CHARLES H. M. BIRD, Los Angeles, Cal.

1,183,727. PNEUMATIC WHEEL. JOSE GREPPI and ANTONIO ROMANACH, Buenos Aires, Argentina.

MAY 23

1,183,844. GAS - PRESSURE REGULATOR. ROBERT N. BAYLIS, Caldwell, N. J.

1,183,846. ROCK-DRILL. GEORGE R. BENNETT, Denver, Colo.

1,183,859. AUTOMATIC PNEUMATIC TIRE-INFLATING MEANS. WILLIAM S. ESTLE, New York, N. Y.

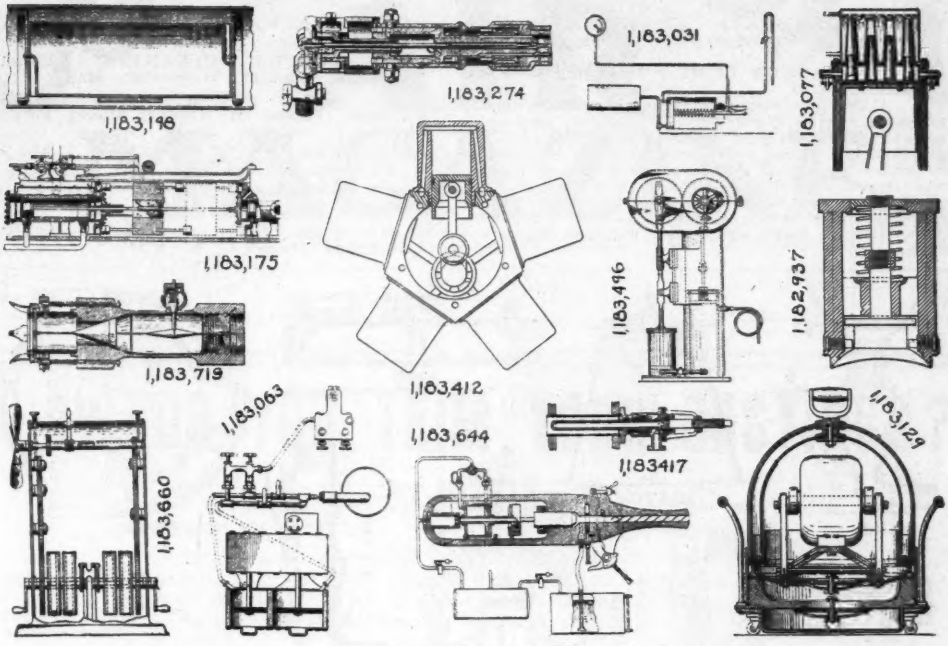
ential cylinders, each having a closed and an open end, a pair of spaced pistons respectively operating in each of said cylinders, each pair of said pistons being connected together through the open ends of the cylinders and to the part to be moved, the closed end of one of said cylinders being constantly in communication with a source of supply of operating medium through a port of large area, communicating with the cylinder at a point intermediate the ends of said cylinder, and also through a port of small area at the closed end thereof, and means for controlling the supply and exhaust of operating medium to and from the closed end of the other cylinder.

1,184,201. SUCTION-CLEANER. HENRY C. NIEMEYER, Racine, Wis.

1,184,249-50-51. PROCESS OF PRESERVING. GEORGE W. LUHRMANN, Jersey City, N. J., and ROBERT MAGRANE, New York, N. Y.

1,184,252-3. APPARATUS FOR PRESERVING. GEORGE W. LUHRMANN, Jersey City, N. J., and ROBERT MAGRANE, New York, N. Y.

1. An apparatus for processing foodstuffs and the like, including a retort, a steam supply, a compressed air supply, automatic means controlling said steam and air and adapted to maintain the interior of the retort at a predetermined



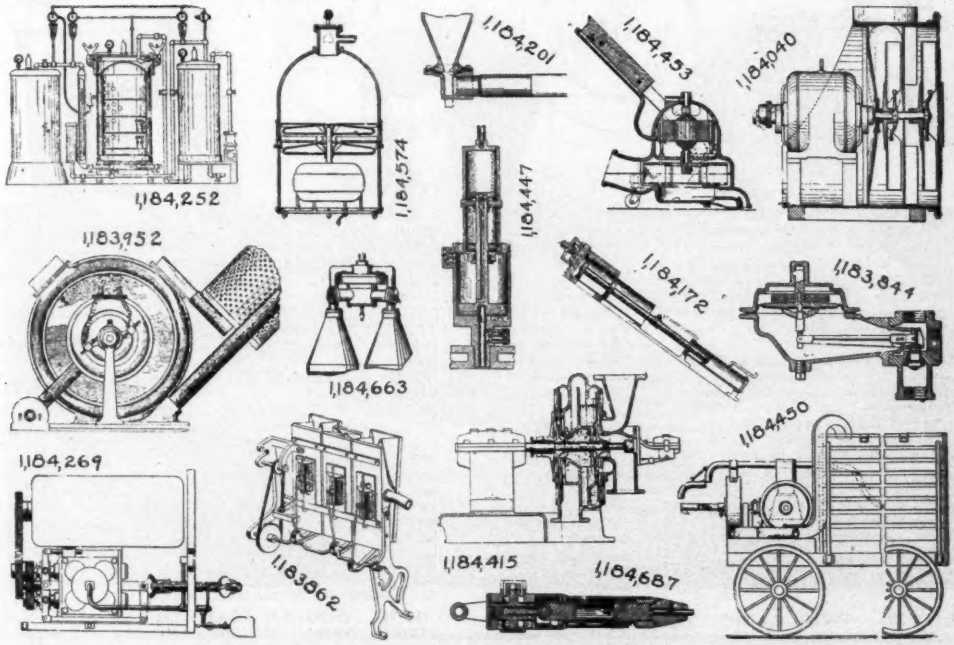
PNEUMATIC PATENTS MAY 16.

temperature and at an independent and predetermined pressure.

1,184,269-70. COMBINED PUMP AND STARTER FOR EXPLOSIVE-ENGINES. FRANK E. TEN EYCK, Auburn, N. Y.

1,184,292. AIR-TORPEDO. PETER G. WING, Chicago, Ill.

1,184,303. APPARATUS FOR FEEDING PULVERIZED FUEL. JOHN E. BELL, New York, N. Y.



PNEUMATIC PATENTS MAY 23.

1,184,403. PNUEMATIC DUST - HANDLING SYSTEM. WHITFORD W. WOODLEY, Elizabeth City, N. C.

1,184,415. VACUUM-PUMP. JOHN J. BROWN, Newark, N. J.

1. A multiple stage vacuum pump unit comprising a casing a plurality of impellers and associated diffusers and walls within the casing dividing the same into compartments into one of which the liquid and gas are delivered from one impeller and its diffuser and passed to another compartment wherein they are permitted to separate and are caused to pass independently to the next succeeding impeller and its diffuser.

1,184,860. PNEUMATIC CONVEYER. GUIDO E. LOB, Chicago, Ill.

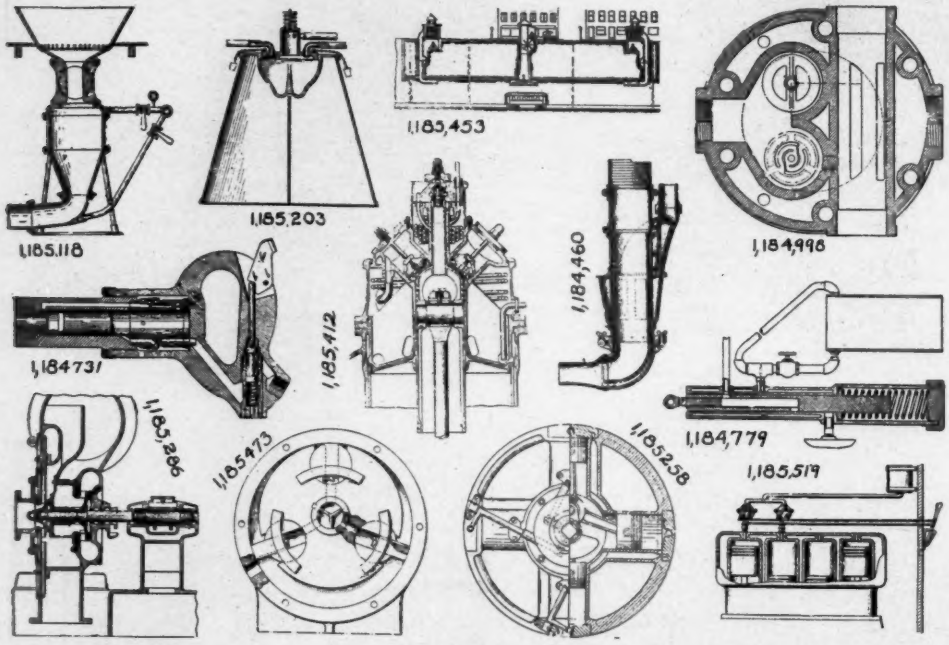
1,184,908. VACUUM CLEANING DEVICE. MORRIS S. WRIGHT, Worcester, Mass.

1,184,953. AIR - SUPPLY - REGULATING MEANS. HARRY F. HITNER, Mount Vernon, Ohio.

1,184,959. PNEUMATIC CLEANER. AUGUST C. HUMMEL, Milford, Ohio.

1,184,998. AIR-COMPRESSOR. PATRICK H. REARDON, San Francisco, Cal.

1,185,103. PNEUMATIC CLEANER. CHARLES A. KILLIES, Syracuse, N. Y.



PNEUMATIC PATENTS MAY 30.

1,184,447. AIR-COMPRESSING APPARATUS. WILLIAM P. HAMMOND, Passaic, N. J.

1. In an impulse pump, the combination of a power cylinder, a cushioning cylinder and a compressing cylinder, connected pistons in said cylinders, a valve-controlled inlet to the power cylinder above the piston therein, a passage affording free communication between the atmosphere and the cushioning chamber, and a valve-controlled passage leading from the power cylinder above the piston therein to the compressing cylinder below the piston therein, substantially as described.

1,184,458-9. VACUUM CLEANING-MACHINE. JAMES B. KIRBY, Cleveland, Ohio.

1,184,574. PNEUMATIC CLEANING APPARATUS. OSCAR ANDRESEN SCHLESINGER, Oakland, Cal.

1,184,663. STEAM VACUUM-PUMP. ABRAM H. SMYTHE, Alexandria, Va.

1,184,687. POWER-ACTUATED PNEUMATIC HAMMER. LOUIS E. GOLLY, Brooklyn, N. Y.

MAY 30

1,184,731. PNEUMATIC HAMMER. FRANK M. FABER, Canton, Ohio.

1,184,779. AERATING FUEL-PUMP FOR EXPLOSIVE-MOTORS. JAMES SHAW, Lodi.

1,185,117-8. MECHANISM AND PROCESS FOR MIXING AND TRANSPORTING CONCRETE AND SIMILAR MATERIALS. JOHN H. MACMICHAEL, Toledo, Ohio.

1,185,203 MILKING MACHINE. VICTOR B. JORDAN, Waterville, Me.

1,185,258. PNEUMATIC CLUTCH. JOHN SPRINGER, Detroit, Mich.

1,185,286. AIR-PUMP. JOHN J. BROWN, Newark, N. J.

1,185,344. AIR-BRUSH. JOSEPH E. PHILIBERT, Houston, Tex.

1,185,354. PNEUMATIC CARPET-SWEEPER. BENJAMIN C. SKINNER, Berkeley, Cal.

1,185,392. AIR FACE-MASK. JOHN M. GANZER, Poughkeepsie, N. Y.

1,185,412. COMPRESSOR. BERNHARD KRAMER, Charlottenburg, Germany.

1,185,453. VENTILATING APPARATUS FOR SUBWAYS. JOHN L. WALKER, Coal City, Ill.

1,185,473. AIR-PUMP. JOHN BUCKLEY, Brooklyn, N. Y.

1,185,489. PNEUMATIC CARRIER. MERTON L. EMERSON, Braintree, Mass.

1,185,519. ENGINE-STARTER. FRANK MAROVITCH, Nelson, British Columbia, Canada.

1,185,608. AUTOMOBILE AIR - SPRING. GEORGE WESTINGHOUSE, Pittsburgh, Pa.